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EDITORIAL

When the Governor-General shall have signed the bill appropriating the sum of ₱125,000 for an experiment station in connection with the College of Agriculture, the new law will open up another important page in the history of agricultural progress in the Philippines. We are now beginning to note the transition into a period when agriculture in the Philippines will have ceased to depend on haphazard, hit-or-miss methods; for with the inauguration of an institution the primary function of which is agricultural experimental research on an organized basis, Philippine agriculture will begin to assume the position of an exact science based on the most modern and well-recognized principles that are calculated to meet local conditions.

The College of Agriculture has for a long time realized the importance of experimental research work along agricultural lines; and has given every opportunity to its more advanced students to carry on investigations of an exact nature. The practical results have been published from time to time in this paper and elsewhere. In the absence of any appropriation for this specific purpose, this phase of college activity has of necessity been very limited. In spite of all its handicaps, this institution has managed to keep on and produce results which, we believe, can be utilized to advantage in solving many baffling local problems which the Filipino farmer constantly and often discouragingly meets.

The experiment station, when well established and with the co-operation of the College of Agriculture, will increase considerably the chances of securing important and highly useful results; and the Filipino people, more particularly the agricultural class, will in due time find their investment more than doubly repaid and will then certainly regret that this station was not created earlier. This has been the case in other countries with similar institutions.

The Philippine legislature can not be too highly commended for their very patriotic attitude in passing this bill. May we not venture to hope that this is the beginning of a series of legislative measures tending to promote the development of scientific agriculture in the Philippines?

Value of Philippine Composts

By Felix Bautista Sarao

Thesis presented for graduation from the College of Agriculture, No. 85.

INTRODUCTION

As one passes through the agricultural parts of the Islands it is not uncommonly found that barnyard manure and the by-products of the farm crops are thrown here and there or abandoned in fields, the farmer having no thought of gathering and putting them under such conditions that the fertilizing value might be preserved for future use. Such evidence shows that most of our farmers do not realize the value of the waste on their farms. Some dump rice husks and other farm refuse into old wells or any depression in the ground for the sake of leveling the surface; others leave them scattered in places where an ordinary heavy rain can easily wash them down into the neighboring creeks or rivers; while others make the great mistake of burning rice straw and trash of other crops to get rid of them as easily as possible. Among our common farmers, neither the loss of ammonia when the decomposing pile is washed with water, nor the loss of nitrogen when the material is burned, is known. At present, they consider farm waste as something of insignificant importance to soil improvement and do not believe it will pay to utilize it. This inattention to farm waste in the Philippines may be accounted for, principally, by the lack of knowledge of its value, which will perhaps not be fully realized until every hectare of arable land of the Philippines is owned and planted, thus giving no chance for a farmer to change his location after the natural fertility of its soil is gone, a condition that will surely be true sooner or later with every field, if fertility is not maintained by some practical means.

In the United States, Europe, China and Japan, where agriculture has reached its fullest development and where intensive farming is practiced, especially in the last two countries mentioned, manure of every kind is very highly valued. In China manure and waste of all kinds, human and animal, are religiously saved and applied to the fields. "In Shantung Province, China, every farmer's household has in the street a soil stack in which they mix manure, ashes, stubble and waste roughage from the field and all household waste, which are then composted on the addition of sufficient water"(1). Here, in the Philippines, we have never heard of people doing such things; nor have we seen them collecting droppings from pasture lands and from along the ways, as is done in China and Cuba, where such materials, are "quickly and eagerly gathered" and composted with utmost care. But if we are to bring our soil to the best physical condition and to increase or maintain its fertility with the least cost, we must utilize on our farms the crop by-products and barnyard manure, and any household waste out of which we can derive soil-enriching elements.

VALUE OF COMPOSTING

Manure, when it cannot be applied fresh, should be composted with the addition of such absorbent materials as saw dust, straw or leaves in order to save its ammonia which escapes by the process of fermentation or "fire-fanging." (4)

By composting, it is not only the nitrogen in the material that is made into available plant food. Potassium, phosphorus and other fertilizing constituents which make a greater percent-

age of the material than the nitrogen, are made more available as plant food. "Composting produces a concentrated fertilizing material in convenient form for handling and in a condition better suited for use on soils than in fresh manure". (1) Hence, composting not only saves labor on the part of the farmer, but also saves time for use on the fields, as the food elements in the composted material are already available when applied.

USES OF COMPOSTING

Well-rotted composts are very serviceable for seed beds. Because of its readily available fertilizing constituents, seedlings grown in it ordinarily acquire that vigorous start which is necessary for a successful growth of all plants. To insure the safety of the seedlings from diseases which might be transmitted to them from the composts, the latter should be sterilized before using.

The application of composts to the fields improves the tilth of the soil, for it is a rich source of humus. All the manure and other by-products of farm crops are largely composed of organic matter, which, after partial decomposition, becomes humus. This organic matter supplies food for the bacteria in the soil which in turn change the mineral matter into more available plant food. (2) Hence the compost applied to the field, besides being a direct source of plant food, helps a great deal in the improvement of the physical condition of the soil, for it makes the heavy soil more porous and the light soil more retentive of moisture. The following quotation emphasizes the value of humus in the soil: "Professor Ladd's investigation shows that as humus decreases in soils they become less productive, less retentive of moisture and inferior in physical quality, while, on the other hand, it was found that an increase in the percentage of humus is accompanied, not only with an increase in the percentage of phosphoric acid extracted with the humus, but also with a greater productivity of the soil. As the humus increases, it seems to cause portion of the phosphoric acid, till then existing in an insoluble form, to become transformed into a soluble form, and thus, presumably, to become more readily available as plant food. The same is true as regards the potash, lime, and other soil constituents. If more attention were given to maintainig an abundant supply of humus (partially decayed organic matter) in soils, they would be more productive, require less artificial fertilizing and respond more generously when commercial fertilizers are used". (5)

TIME OF APPLICATION OF COMPOSTS

Composts should be applied to the field as soon as "ripe", that is, when the rough material is at that stage when nitrification is taking place actively. When several fields are to be supplied with compost at different times, it is recommended that compost heaps be made on different dates. (4) In China, before applying the compost to the field, the fermented material is dried a little in the sun. It is then thoroughly mixed with fresh soil and ashes. Repeated turning promotes aëration, and therefore favors nitrification. (1)

MATERIALS FOR COMPOST

On our farms the by-products or the waste that may be composted and utilized are: trash from corn, sugar cane and sorghum; stems and leaves of banana, tomato, egg-plant, peppers and cassava, etc., leaves of bamboo, coconut and mango and other trees; lawn cuttings and herbaceous weeds; cogon and talahib; vines of sweet potato,

squashes, beans and the like, rice straw and husks; and farm yard manure with urine, and all house refuse.

It is important to see that no diseased plants or by-products from the same are composted without thorough disinfection. Otherwise the harmful fungi or bacteria in the material, if not killed during the time of decomposition, may find their way to the crop in the field to which the compost is applied. If there is no way of disinfecting, it is much better to burn the materials completely and be satisfied with the nonvolatile fertilizing constituents of the ash.

METHODS OF COMPOSTING

Inasmuch as there are hundreds of kinds of materials which can be composted, various ways of composting might be expected.

One method of composting, an ancient Roman practice, is that of digging a hole at a convenient distance from the house and then connecting the hole with a canal to the kitchen sink. Into this hole are dumped sods, weeds, sweepings from the house, etc., while the liquid refuse passes in through the canal. In order to prevent or avoid the bad odors arising from the hole, every layer of material is followed by a covering of soil. In this way good manure is obtained. (4)

Another simple method of making compost is the one described by Jared Eliot in 1747. He had a long cowyard into which he drove his animals every night. At an interval of once a month plowed the land in the yard thoroughly, repeating this through the entire summer, after which he took the compost to his field. He said: "the whole furrow of earth has become dung, making an increase beyond what one would imagine. (4)

These last two methods described are called "the rough and ready method of making compost".

In Kiangsu Province, China, "pits are dug near the margin of the reservoirs and into them are thrown coarse manure and any roughage in the form of stubble or other refuse which may be available, those materials being saturated with the soft mud dipped from the bottom of the reservoirs". (1)

In the Nara Experiment Station they have what is called a compost house:

Its floor is 12 by 18 feet, rendered water-tight by a mixture of clay, lime and sand. The walls are of earth, one foot thick, and the roof is thatched with straw. Its capacity is 16 to 20 tons, having a cash value of $30. In preparing the stack, materials are brought daily and spread over one side of the compost floor until the pile has attained a height of 5 feet. After one foot in depth has been laid and formed, 1.2 inches of soil or mud is spread over the surface and the process repeated until full height has been attained. Sufficient water is added to keep the hole saturated and to maintain the temperature below that of the body. After the compost stocks have been completed, they are permitted to stand five weeks in summer, seven weeks in winter, when they are forked over and transferred to the opposite side of the house". (2)

Banana leaves and stems have been composted in Cuba by interlaying dirt in a space of about 8 by 10 meters. The trunks are never cut or sliced into pieces. The piling of the material is done a little before the rainy season and at the end of the season the pile is rotted and ready for use. (4)

Other methods of composting used in other places might be given. Most of these methods, however, seem too complicated or too expensive for the ordinary farmer. With a view of finding a method which, while saving most of the nitrogen, is still easy of application

and requires no particular kind of housing, etc., and which would be particularly suited to the conditions in the Philippines, the writer undertook the experiments described below.

PRESENT WORK

Objects.—The objects of the present work were: (a) To determine the rate of decomposition of different materials when each is composted under four different conditions; (b) to determine shrinkage after composting; (c) to determine the percent of moisture and nitrogen in the compost.

Materials used.—The materials used were: (1) Corn trash; (2) cane trash; (3) mixed herbaceous plants; (4) rice straw; (5) cogon; (6) banana stems and leaves; (7) bamboo leaves; (8) sorghum trash.

The mixed herbaceous plant piles were composed of tomato (½ of the pile), peas (¼ of the pile), and *Amarantus* and other weeds (¼ of the pile).

Methods of composting.—Each of the materials was piled under the following conditions: (1) walled and open, (2) walled and shaded, (3) unwalled and open, (4) unwalled and shaded.

The walls or receptacle in which the materials were put were made of bamboo. They were constructed so as to have the same capacity—having the dimensions of 2 by 2.2 meters.

The quantity of materials placed in the receptacles was made as equal as possible to the amount of materials just piled on the ground. While filling these receptacles, the materials were continually compacted by stamping one layer after the other. The same thing was done with the other piles without walls, but due to the absence of the walls, it was hard to make them as compact as those in the receptacles, for the piles have no restraining boundary, the bases became greater than the bases of the materials in the receptacle. This was corrected by piling again on the top of the pile the material at the edge of the bottom,—consequently conical piles were formed.

These materials were not composted with any other admixture, e. g., lime and ash, as is done in other methods of composting.

The rate of decomposition of each pile was observed and noted, as shown in the following discussion.

OBSERVATION AND RESULTS

Rate of Decomposition.—The rate of decomposition of the material is partly controlled by the weather conditions. The more humid the air, the faster the decomposition. Rainy days hasten decomposition. In all cases it was observed that the outside of the piles being more susceptible to aëration, which favors the decay, the decomposition started there and spread to the center. Of the outside portion, that at the edge of the base of the piles had the maximum rate of decomposition, because it was more constantly moist than the rest of the pile, besides being exposed to the air. On the other hand, middle layers of the piles were under opposite conditions and consequently had the minimum rate of decomposition.

The rate of the decomposition of each pile is given in Table I. Of the unwalled piles, those in the shade had a faster rate of decomposition in all cases than those in the open. Of the walled piles, there was not much difference in the rate of decomposition and only cane trash, bamboo leaves and sorghum trash had a faster rate in the open than in the shade. The materials with a maximum rate of decomposition were banana stems and leaves, and that which had the minimum

was cogon. The average rate of decomposition for all the materials was 232 days.

Shrinkage.—In composting any material, there is always a loss in volume. To find the amount of shrinkage in the composted material the following experiment was performed.

Oil cans of known capacity were filled with the raw material used in the compost piles. These were allowed to decompose and after decomposition the volume of the composted material was taken. The banana stems and leaves had the greatest shrinkage, while the cogon, had the least. The average shrinkage of the material on composting is 84 per cent.

MOISTURE AND NITROGEN DETERMINATION

Samples of raw and rotted materials from each compost were analyzed for moisture and nitrogen.

Sampling.—The samples for analysis were taken by mixing thoroughly the compost pile and quartering it successively until samples of proper size were obtained.

The moisture was determined by drying in the water oven at 100°C to constant weight.

The nitrogen was determined by the modified Gunning method, as given in Bulletin No. 107, Official Methods of Analysis. The per cent of nitrogen and moisture in the compost is given in Table II.

If the walled and unwalled piles are compared under each of the conditions —open and shaded—it is found that five in the open and walled had higher nitrogen and only three had less than those in the shade. This same ratio was maintained in the shaded piles, and again, it was in favor of the walled. The above statements lead to the conclusion that the best results may be obtained by walling the compost piles, whether they are in shade or exposed. However, if the piles are not to be walled at all, better results would be obtained by having them exposed. The heat of the sun has a favorable effect on the amonification in the organic matter up to a certain degree. The optimum temperature is about 30°C. Too high heat would bake the compost and cause the evolution of ammonia. Hence, placing the unwalled piles under direct sunlight is not always safe.

Of the materials under test the highest per cent of nitrogen in the compost is in cane trash and the lowest in cogon. The mixed herbaceous plant compost has the highest nitrogen in the walled shaded condition, but due to the low percentages under the other conditions the average is brought down. In the unwalled open condition the cane trash has the highest per cent of nitrogen and the cogon the lowest.

TABLE I
RATE OF DECOMPOSITION AND SHRINKAGE

Material	*Compost Pile Condition*				*Average rate of decomposition*	*Shrinkage of volume during compositing*
	Walled		*Unwalled*			
	Open	*Shaded*	*Open*	*Shaded*		
	days	days	days	days	days	%
Corn trash	171	160	181	152	166	89
Cane trash	181	200	212	190	196	89
Mixed herbaceous plants	176	150	163	140	157	74
Rice straw	149	140	159	100	137	79
Cogon	510	510	500	480	500	71
Bamboo leaves	200	230	250	200	220	88
Banana stems and leaves	100	96	109	99	101	95
Sorghum trash	342	380	380	371	368	89
GENERAL AVERAGE	229	233	244	217	232	84

The writer attempted to find the actual loss of nitrogen during composting, but, having no record of the moisture of the raw materials before composting, only a rough estimate of the loss can be given. The per cent of moisture used in the computation was obtained from similar materials which might have had either higher or lower in moisture content than the materials actually composted. As a result of this inaccurate estimation three out of eight materials showed a slight gain of nitrogen, which is contrary to what should be expected.

Based on dry weight in each case, it was found that the compost had a higher per cent of nitrogen than the similar raw materials. This percentage gain of nitrogen in the compost was accounted for by the reduction of organic matter into carbon dioxide and water during decomposition, while the nitrogen was to a considerable extent left behind as ammonium salts and nitrates. .Table III gives this percentage increase.

The loss of nitrogen from any compost pile is unavoidable. The loss occurs in two ways: in gaseous form as nitrogen and as ammonia; and, by leaching, as ammonium salt and as nitrates. But in spite of these losses it would pay to compost the materials instead of burning. One hectare of corn has about 1250 kilos dry weight of trash which contains about 6.0 kilos of nitrogen. By composting, 3.4 kilos remain and 1.7 kilos are lost. At ₱0.60 a kilo, this is worth ₱2.58. That much is lost in nitrogen alone in burning the cane trash from one hectare. One hectare of sugar cane has about 1700 kilos dry weight of trash, which contains about 8.2 kilos of nitrogen. All these, besides the organic matter, is lost by burning. In burning the by-products of the farm year after year the soil supply of organic matter is cut off. When this happens, the soil becomes more and more depleted due, not only to the lack of nitrogen, but also to the lack of an important constituent—the organic matter which cannot be added to the soil by the application of commercial fertilizers. By composting, not only is the nitrogen saved, but the organic matter is left in a form more available than in the raw material.

TABLE II

PER CENT OF MOISTURE AND NITROGEN

	Walled				*Unwalled*				*Average % of nitrogen in each material*	*Average % of moisture in each material*
	Open		*Shaded*		*Open*		*Shaded*			
	% of moisture	*% of nitrogen*	*% of moisture*	*% of nitrogen*	*% of moisture*	*% of nitrogen*	*% of moisture*	*% of nitrogen*		
Corn trash	63.62	.95	78.25	1.17	64.42	.68	61.81	.54	.84	67.03
Cane trash	75.24	.57	74.60	1.04	71.50	1.06	59.44	.93	.90	70.19
Mixed herbaceous plants	59.24	1.01	60.12	1.25	42.99	.59	36.99	.53	.84	49.83
Rice straw	65.92	.77	62.34	.74	82.67	.80	68.13	.87	.79	69.75
Cogon	54.51	.37	44.62	.33	36.69	.32	36.66	.48	.38	41.37
Bamboo leaves	45.96	.85	34.03	.76	40.86	.78	58.24	.76	.79	43.37
Banana stems and leaves	45.57	.42	67.60	.85	57.10	.83	53.27	.64	.68	56.38
Sorghum trash	59.26	.82	57.97	.60	31.38	.56	27.61	.47	.61	43.98
	58.91		59.98		53.45		49.67			

TABLE III

PERCENTAGE INCREASE OF NITROGEN IN THE COMPOST

Material	*Net Raw*	*Wt. Composted*	*% of Moisture Raw*	*% of Moisture Composted*	*% of Nitrogen Raw*	*% of Nitrogen Composted*
Corn trash	1567	2227	27.53	79.76	.48	.84
Cane trash	1583	3250	24.93	78.73	.48	.90
Mixed herbaceous plants	3867	2433	48.15	80.28	.55	.84
Rice straw	1920	3403	51.94	77.96	.44	.79
Cogon	2060	3027	40.68	82.30	.56	.38
Bamboo leaves	2175	2750	43.68	77.90	.37	.79
Banana stems and leaves	4700	1067	54.80	86.34	.06	.68
Sorghum trash	2893	2326	38.35	64.18	.43	.61

CONCLUSIONS

1. Compost from walled piles contained the highest per cent of nitrogen.

2. The compost containing the highest, per cent of nitrogen was obtained from the cane trash and the next highest, from the corn and mixed herbaceous plants.

3. Banana stems and leaves and rice straw composted the most rapidly.

4. During composting, banana leaves and stems had the highest shrinkage and the next highest were trash of corn and sorghum. The cogon had the lowest shrinkage.

5. The loss of nitrogen by weight in composting remained undetermined. No relation between rate of decomposition and the percent of nitrogen contained in the compost was found.

RECOMMENDATIONS

1. The farm by-products should not be burnt but should either be composted or plowed under, in order to save the nitrogen and organic matter.

2. When composted, the piles should be walled and should be opened or exposed according to the weather conditions.

3. When unwalled, piles should be left exposed to the sun as much as possible.

ACKNOWLEDGMENTS

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Selection of Some Standard Ilocano and Tagalog Lowland Rices

By Mariano E. Gutierrez

Thesis presented for graduation from the College of Agriculture, No. 81.

With the already large area given to rice in the Philippines, the further extension of territory for its culture is not desired at present. The problem to be solved is how to increase the production so that rice growing will pay good returns on the capital employed. Every means for the improvement of rice in the way of culture, fertilization, irrigation, and amelioration of the plant itself should be given attention. Every year of delay in these lines of improvement means so much delay in reaching economic independence and means many millions of pesos' loss to the country. If all the institutions of the government having to do with material development can, through their work, make the Philippines independent in rice, then the government will have achieved a great work. The Bureau of Agriculture is alive to this fact and has worked towards the improvement of Philippine rice culture. Ever since the establishment of the College of Agriculture work on rice has been constantly in progress. Works on the breeding, botany, judging of rice, fertilization, the cost of production by native methods, etc. have already been published by Rundles, Zamora, Balangue, Aurelio, and Crisóstomo in The Philippine Agriculturist and Forester.

Plant breeding in the Philippines is very new. The publication of Jacobson's "Head-to-the-Row Tests with Rice" and Mendiola's "Hybridization of Corn" two and a half years ago marked the birth of plant breeding in this country, as previously pointed out by this journal. These two works were carried out in government institutions. Among the common farmers, plant breeding is conspicuous by its absence. Even the benefits of mass selection are practically unknown, and if known at all, are not appreciated. With rice the varieties are not even kept pure. The writer has critically studied about 200 varieties of seed samples from many parts of the Philippines and found many of them consisting of two or more distinct varieties. In the field the mixtures of varieties are very evident to the casual observer. Often they are very marked, as when two varieties of different hull colors grow together, in which case a glance at the field will reveal the fact.

The present work deals with the improvement of the rice plant itself by seed selection. The increase of production by seed selection alone is recognized in modern agriculture as one of the most important factors in increasing yields per unit of area. The advantage of seed selection over the other lines of improvement is that with the same methods of culture in vogue, with the same area used, and with the same cost of operation, the production is increased without extra outlay of capital, since it costs as much to produce a poor unproductive strain as a productive one.

The variability of rice as a basis for selection is now well recognized. This followed on the discovery of the elementary species, or biotypes in other cereals, such as wheat, barley, oats, etc. In Java and Japan selection of rice has resulted in the separation of many pure lines. This work consists in producing extensive, successive cultures from single highly desirable parent plants. This

is known as the Svalof system of selection. Dean Copeland (2) reports that the Javanese farmers are growing superior strains which were distributed by the government.

H. O. Jacobson (3) of the Bureau of Agriculture has isolated four so-called new varieties, which are but productive strains of known sorts and these have been multiplied and distributed to some 5000 farmers. In a letter, dated May 13, 1916, to the writer from the Bureau, the average yield for the four improved varieties for two years is calculated to be 2301 lbs. per acre which is over four times the general average for the Philippines. (1) This shows well the enormous potential possibilities in selection.

OBJECT OF THE INVESTIGATION

The main object of the present work is to make a beginning in the isolation of productive strains of some Ilocano and Tagalog lowland rices of general cultural value.

VARIETIES STUDIED

Four Ilocano or bearded rices were studied; namely, 5893 Ganado, 5894 Iroy, 5895 Binalayan, and 5896 Dequet á Bolilising, the last being a glutinous variety. Only two Tagalog or non-bearded varieties were studied; namely, 5892 Binangbang and 5891 Binicol. More stress was laid on the selection of Ilocano rices than on the Tagalog varieties for the reason that the four improved Bureau of Agriculture varieties are non-bearded. Sr. Matias Gonzalez, President of the Second Farmer's Congress and of the Pangasinan Agricultural Association, stated to the writer that the people of Pangasinan do not care for the improved rice seeds distributed by the Bureau, and expressed the opinion that since Pangasinan is the "granary" of the Philippines the rices in general culture there should be improved also. At this time the work of selecting rices for this investigation was in progress and it was thought advisable to enter the fields of Pangasinan in search of productive parent plants. Through President Gonzalez's, son, Mr. Manuel A. Gonzalez, Manager of the Hacienda, Esperanza, the writer was introduced to the principal rice growers of the hacienda. Hacienda Esperanza is an extensive rice area of about 5000 hectares and includes several municipalities. There rice seems to be at home. The varieties Ganado, Binalyan, and Dequet á Bolilising were collected in Rosales; Iroy was collected in Santo Tomas. Early rice was not collected as work in the college did not permit the writer to leave for Pangasinan sufficiently early. Selections were made there during the Christmas vacation of 1915.

Selection of all desirable parent plants was made outside the college, there being no extensive college cultures of lowland rices at that time. In September of the same year, Binicol was collected from rice fields in Bay, Laguna. In February, 1916, Binangbang was collected from the control plots of Mr. Balangue's fertilizer investigations and from adjoining fields in Calauang.

Octubre (4) describes two of the varieties studied as follows:

GANADO, ORIGIN, PANGASINAN

"Cultured as lowland rice. Flowers in 144 days; matures in 185 days. The plant is about 197.6 cm. high; number of culms per stool usually 7. Culms usually prostrate at maturity; about 166 cm. long. Number of nodes usually 5 to 6, length about 4.6 mm.; diameter about 6.7 mm.; color at flowering time amber or dark oil-green; the second node from the base, with aerial roots. Internodes usually 5 to 6; about 32.4 cm. long, 6.1 mm. in diameter; color

at flowering time light yellowish green, at maturity brownish straw yellow; number entirely enclosed by their corresponding sheaths 3. Standard leaves usually 9. Blade rather broad; about 78.6 cm. long, about 10.9 mm. broad, color grass green, dorsal surface glabrous throughout; ventral surface scabrous throughout, tip medium acute, base medium narrow; margin usually hispid. Sheath about 32.5 cm. long, dorsal surface grass green, somewhat hispid near the junction, ventral surface reddish purple at base. Junction purple. Ligule very long, translucent, about 4.5 cm. long. Auricle purple, with long purplish bristles. Roots almost uniform about 1.65 mm. diameter, color reddish brown; medium fibrous, number about 261. Panicle about 31.4 cm. long, rather diffuse, color at flowering time partly purple and partly green, at milk stage reddish purple; at maturing time cream buff. Primary branches usually 16 in number; arrangement crowded at base, irregular alternate toward the tip; secondary branches per primary usually 1 to 5. Flowering glumes very hispid; color partly purple and partly green. Empty glumes mostly lanceolate, dark reddish purple, about 1/3 as long as the flowering glumes. Ovary about 1.2 mm. long 0.7 mm. in diameter; stigma dark reddish purple, about 1.5 mm. long, 0.7 mm. diameter; filaments about 7.6 mm. long; anthers about 2.8 long, 0.8 mm. broad. Caryopsis somewhat lanceolate, weight about 32 mg., about 9.3 mm. long, 3.1 mm. broad, 2 mm. thick; about 287 per panicle, about 17 per primary branches. Hull color cream-buff, surface very hispid, tip Mars-brown with long awns of reddish purple color, about 32.2 mm., scabrous, strong, bristles very small but stiff and silvery at flowering time. Grain elongate elliptical, weight about 26 mg., about 7.2 mm. long, 2.5 mm. broad, 1.8 mm. thick. Cuticle translucent. Endosperm partly vitreous. Nonglutinous.

"Remarks: This is a very common variety of lowland rice in Pangasinan. It is largely grown for market. It is easily recognized by the color of its caryopsis at maturing time."

DEQUET Á BOLILISING, ORIGIN, PANGASINAN

"Cultured as a lowland rice. Flowers in 135 days; matures in 170 days. The plant is about 187.6 cm. high; number of culms per stool usually 8. Culms partly prostrated at maturity; about 168.7 cm. long. Number of nodes usually 5 to 6, length about 5 mm.; diameter about 7.6 mm.; color at flowering time dark oil-green or purplish green; the third node from the base, with aerial roots. Internodes usually 5 to 6; about 32.4 cm. long, 6 mm. in diameter; color at flowering time distinct yellowish green, at maturity straw yellow; number entirely enclosed by their corresponding sheaths 3. Standard leaves usually 9. Blade slender; about 86.7 cm. long, about 15 mm. broad; color green; dorsal surface somewhat smooth; ventral surface somewhat scabrous; tip not very narrow, base medium narrow; margin hispid. Sheath, about 34.1 cm. long, dorsal surface light green, ventral surface pale grass-green. Junction purple. Ligule translucent white, about 4.0 cm. long. Auricle purple in color. Roots very uniform; about 1.5 mm. in diameter, color reddish brown; fibrous, number about 280. Panicle about 30.4 cm. long rather diffuse, color at flowering time yellowish red; milk stage yellowish red; at maturity English-red. Primary branches usually 13 in number; arrangement crowded, irregular; secondary branches per primary usually 1 to 5. Flowering glumes reddish yellow color. Empty

glumes cream colored, lanceolate, about 1/5 as long as the flowering glumes. Ovary about 1.2 mm. long about 0.6 mm. in diameter; stigma dark purplish red, about 1.5 mm. long, 0.6 mm. in diameter, filaments about 8.3 mm. long; anthers about 2.8 mm. 0.8 mm. broad. Caryopsis somewhat elliptical, weight about 36 mg., about 9.7 mm. long, 3.5 mm. thick; about 208 per panicle, about 15 per primary branches. Hull color almost English-red, surface hispid, tip red awned 59.9 mm. long. Bristles, long and numerous. Grain elongate elliptical, weight about 30 mg. 7 mm. long 2.7 mm. broad; 1.8 mm. thick, white cuticle. Endosperm calky glutinous.

"Remarks: This is a very common glutinous rice of northern parts of Luzon and in Pangasinan. It can be recognized in the field at flowering time by the distinct red color of each panicle".

The other four varieties are not described in Mr. Octubre's work. In the absence of a botanical synopsis to identify them, the variety names as given by the locality, were retained. Some study of them was made in order to be sure that the varieties to be cultured were not mixed sorts. The following are some remarks concerning each variety.

5894 *Iroy.* Origin, Hacienda Esperanza, Pangasinan. This is a very late lowland, bearded variety. Culm length, about 166 cm; average number of culms, 6; color of hull, light straw. Shape of grain, lanceolate with oval cross section; dimensions, 9 mm. x 3 mm. x 2.1 mm.; texture of grain, vitreous. Average weight of caryopses per plant, 12 grams. Plant prostrate at maturity. Matures in about 210 days. Generally grown in Hacienda Esperanza.

5895 *Binalayan.* Origin, Hacienda Esperanza, Pangasinan. This is a very late lowland, bearded variety. Culm length, about 159 cm.; number of culms, 5; color of hull, straw. Shape of grain, lanceolate with oval cross section; dimensions, 8.8 mm. x 3.1 mm. x 2.1 mm.; texture, largely vitreous. Avergae weight of caryopses per plant, 10 grams. Plant, reclining at maturity. Matures in about 208 days. Of general culture in Pangasinan.

5982 *Binangbang.* Origin, Calauan, Laguna. This is a very late lowland, non-beared variety. Culm length, about 134 cm.; number of culms, 7, color of hull, straw; shape of grain, elliptical with oval cross section; dimensions, 8 mm. x 3.3 mm.; texture, largely vitreous. Average weight of caryopses per plant, 8.5 grams. Plant prostrate at maturity. Matures in about 215 days. This variety is generally grown as a late variety in Laguna.

5891 *Binicol.* Origin, Bay, Laguna. This is a lowland or upland, non-bearded, early variety. Culm length, about 113 cm.; number of culms, about 4; color of hull, straw. Shape of grain, elliptical with oval cross section; dimensions, 7 mm. x 3.2 mm. 2.1 mm.; texture of grain, largely vitreous. Average weight of caryopses per plant 7 grams. Plant, erect. Matures in about 135 days.

This variety is a favorite among Laguna people on account of the fine delicate aroma and good cooking quality. It costs more than the ordinary variety, and, for this reason, often only the well-to-do can afford to use it.

METHOD OF SELECTION

Selections were made in the fields a few days before harvest. In the work in selecting, certain precautions were observed. Selections were made at about the middle of the fields and where the stand appeared to be a fair average of the whole paddy. Favored places, such as the borders, where the plants showed better than the rest on

account of more favorable environmental conditions, were avoided. The number of plants per hill varied in Pangasinan from 2 to 4, and in Laguna the number sometimes went higher than 4. Under such conditions no one is quite sure that he is collecting desirable single parent plants. Keeping the number of plants per hill in mind, the clumps having many uniform medium-sized panicles which were borne at about the same height, and are free from diseases of any kind, were collected. Erect plants were preferred to prostrate ones.

The culms of each clump, or hill, were tied together, and by means of bolos the plants were taken out with roots, which were washed clean and brought to the college.

It should be noted in passing that in most of the fields visited there were mixtures of varieties. In Calamba, the varieties Mangasá and Dinagat were collected, but were finally discarded for this reason, these varieties frequently occurring together in about the same proportion.

In the laboratory the clumps of rice were disentangled in order to separate the single plants. To be sure that single individuals were separated the connections of the culms at the base was ascertained; while in cases of doubt the plants were discarded. The best plants were retained, and the bad and indifferent,—those not conforming to type and doubtful cases—were put aside. For every variety, about 100 individuals were selected in this way. When some of these turned out to be poor they were put aside. Each individual selection was given a separate number. The average for the variety was taken and those below average were not cultured. This explains why the 100 originally selected plants in the laboratory were reduced to 40 parent plants or less, for the test-row cultures. In all, there were 177 test-row cultures.

The individual selections were studied in detail in order to eliminate admixtures.

NUMBERING

The first number is the college number. The second, which is the number given by the writer, consists of four figures. The first, which is zero, is used to distinguish it from other numbers. The second represents the series for one variety and the last two stand for the number of the individual plants. The last two figures from 00 to 99 make 100, corresponding to the number of originally selected plants for every variety. Thus, Ganado, selected plant No. 1, will bear this number—5893-0400.

METHOD OF PLANTING

The only way to know the real worth of an individual selection is to plant its seeds separately either in rows or in plots. The progeny is then carefully studied and compared with others. Rice is usually self-pollenized, which fact renders the whole work very simple. As has been noted in the foregoing paragraphs, this is known as the Svalof system of selection, because it was first used to accomplish far-reaching practical results in the Swedish station of that name. Individual test rows that show very desirable results, breed true to type and remain constant from generation to generation, are what the breeder is seeking.

The seeds of the single selected parent plants appearing in Table I were soaked for 24 hours and on May 20, 1916, each lot was was planted in a small seed bed enclosed by a bamboo frame 30 centimeters by 30 centimeters placed in the middle of a well prepared seed bed. They were accurately labeled.

Considerable variation was noticed in germination among the seeds of different individuals belonging to the same variety.

Growth measurements of the seedlings were taken when they were 27 days old. They were averaged for each number; these averages are classified according to height and their frequencies for each variety and appear in Table II.

Two weeks before transplanting the paddy was plowed dry to cause the decay of aquatic plants which grew there while the paddy contained water. After one week the paddy was flooded and the *suyod* (a) was run over the paddy several times until the soil was well puddled and uniform.

On June 24, 1916, when the seedlings were 35 days old, they were transplanted. Previous to transplanting, they were removed from the small seedbeds with ½ to 2/3 of their tops cut off, tied with their labels and each number was planted in one row. The rows were spaced 25 centimeters apart and the hills were 20 centimeters apart, only one seedling was placed to the hill. The rows were labeled with long bamboo stakes; the numbers were written with India ink. At the ends of the paddy, border rows were also planted. In the same paddy seedlings of unselected stock were planted for comparison with the test rows.

The paddy was not flooded for several days; when most of the seedlings showed signs of recovery, a continuous inflow and outflow of water were allowed. When the rice had just passed the milk stage, the paddy was closed.

Considerable variation in growth and in tillering was observed within each variety. The plants of some rows grew more vigorously than others. Some rows were more thrifty than the others. Some individual rows showed greater propensity for tillering than others.

TABLE I.—SELECTED PARENT PLANTS

Plant Number	*Length in cm. of culms*	*Total Number of culms*	*No. bearing culms*	*Wt. of caryopses in grams*	*Plant No.*	*Length in cm. of culms*	*Total number of culms*	*No. bearing culms*	*Wt. of caryopses in culms*
5893–0401	145.0	4	3	11.0	5893–0466	137.5	3	3	9.6
5893–0402	138.0	4	4	10.9	5893–0449	147.5	2	2	12.9
5893–0403	138.5	4	4	13.0	5893–0456	142.5	2	2	9.2
5893–0405	133.0	4	3	10.7	5893–0471	153.0	2	2	12.5
5893–0407	149.5	2	2	10.0	5893–0477	141.5	3	2	10.4
5893–0408	134.5	4	4	17.7	5893–0478	136.5	3	3	9.9
5893–0409	131.0	3	3	16.8	5893–0482	160.0	3	3	11.8
5893–0412	135.0	4	4	13.7	5893–0486	143.0	4	4	14.0
5893–0413	146.5	3	3	14.0	5893–0487	132.0	3	3	10.2
5893–0414	159.0	3	2	10.6	5893–0489	134.3	3	3	12.7
5893–0415	131.0	7	5	15.2	5893–0490	148.5	5	4	15.0
5893–0416	132.0	4	4	10.8	5894–0500	165.0	2	2	13.3
5893–0417	141.5	3	3	11.9	5894–0501	155.6	6	6	27.8
5893–0418	137.0	3	3	12.4	5894–0502	159.5	7	7	32.5
5893–0419	158.5	3	3	12.4	5894–0503	172.5	4	4	17.6
5893–0420	157.5	3	3	11.5	5894–0504	186.5	5	5	31.3
5893–0421	143.5	3	3	13.0	5894–0507	169.0	4	4	15.2
5893–0424	145.5	4	4	12.5	5894–0509	160.0	3	3	17.3
5893–0426	117.5	5	4	21.3	5894–0510	184.0	5	5	25.2
5893–0427	129.0	3	3	10.0	5894–0511	153.0	3	3	16.9
5893–0428	142.3	4	4	23.2	5894–0512	171.0	3	3	14.4
5893–0429	136.0	3	3	10.1	5894–0514	161.0	3	3	13.9
5893–0431	158.5	4	4	18.5	5894–0515	163.5	4	4	20.5
5893.0433	146.0	3	3	14.7	5895–0637	147.5	4	4	12.0
5893–0434	135.5	4	4	15.8	5895–0638	160.5	3	3	12.7
5893–0435	148.5	4	4	12.1	5895–0639	146.5	4	4	14.2
5893–0438	154.5	3	3	10.6	5895–0640	160.5	4	4	17.2
5893–0439	141.5	3	3	12.4	5895–0641	150.0	3	3	15.2

(a) A crude native harrow.—Ed.

TABLE I.—SELECTED PARENT PLANTS—*Continued.*

Plant Number	*Length in cm. in culms*	*Total number of culms*	*No. bearing culms*	*Wt. of caryopses in grams*	*Plant No.*	*Length in cm. of culms*	*Total number of culms*	*No. bearing culms*	*Wt. of caryopses in culms*
5895–0642	144.5	5	5	20.7	5894–0545	181.5	4	3	14.8
5895–0643	139.0	4	4	19.2	5894–0546	174.5	4	4	21.4
5895–0644	153.0	6	5	15.3	5894.0554	164.5	2	2	16.6
5895–0645	147.0	3	3	14.3	5894–0555	194.5	3	3	14.4
5895–0647	163.5	3	3	10.4	5894–0563	133.5	2	2	13.2
5895–0648	176.5	3	3	11.6	5894–0570	176.5	4	3	12.3
5895–0650	163.0	5	5	18.5	5894–0571	188.5	3	3	12.6
5895–0655	144.5	3	3	11.0	5895–0602	171.0	3	3	12.1
5895–0663	151.0	3	3	11:2	5895–0603	155.5	5	4	15.3
5895–0680	161.5	4	3	10.1	5895–0607	167.0	4	4	11.7
5895–0687	159.0	4	3	10.2	5895–0609	148.0	4	3	10.3
5895–0695	171.0	3	3	11.2	5895–0612	151.5	3	3	10.8
5896–0700	145.6	6	6	20.2	5895–0614	178.0	5	4	12.1
5896–0701	160.0	3	3	12.5	5895–0615	149.5	4	4	10.1
5896–0702	148.0	5	5	11.8	5895–0617	157.5	5	5	12.5
5896–0703	160.0	8	7	22.7	5895–0618	156.0	4	4	16.2
5896–0704	186.5	8	5	16.0	5895–0619	157.5	3	3	10.1
5896–0705	165.0	4	4	18.4	5895–0620	154.5	5	5	16.9
5896–0706	162.5	4	4	13.0	5895–0621	152.5	5	4	13.5
5896–0708	143.0	3	3	11.3	5895–0622	140.1	4	4	21.7
5896–0711	160.5	4	4	12.5	5895–0624	148.5	4	3	10.9
5896–0712	156.0	4	3	12.8	5895–0625	167.5	4	4	13.0
5896–0713	133.5	4	4	14.0	5895–0626	160.5	6	6	14.3
5896–0714	136.5	3	3	9.6	5895–0627	165.5	6	5	14.5
5896–0716	147.0	5	5	14.2	5895–0630	141.5	4	3	13.5
5896–0717	166.0	3	3	10.0	5895–0631	142.5	4	4	12.4
5896–0718	161.0	5	5	13.0	5895.0632	167.0	5	5	14.8
5896–0719	156.5	5	5	14.1	5895–0633	162.5	4	4	12.8
5896–0722	166.0	4	4	13.0	5895–0635	161.5	3	3	14.9
5896–0723	164.5	3	3	12.3	5895–0636	145.5	4	4	14.6
5896–0726	147.0	3	3	9.7	5892.0803	127.0	5	4	11.8
5896–0728	141.0	6	6	14.5	5892–0804	121.0	5	5	13.7
5896–0731	155.0	3	3	10.0	5892–0805	109.5	5	4	10.4
5896–0734	158.0	4	3	10.7	5892–0806	111.5	5	5	9.9
5896–0738	156.5	4	4	10.6	5892–0807	110.5	5	5	11.0
5896–0741	152.5	5	5	15.0	2892–0808	110.0	4	4	13.0
5896–0754	153.0	4	4	15.0	5892.0809	121.5	8	7	23.2
5892–0800	107.5	5	4	10.4	5892–0810	119.0	4	4	8.9
5892–0801	134.5	5	4	10.7	5892–0811	99.5	5	4	11.2
5892–0802	118.5	4	3	9.7	5892–0812	112.0	3	3	11.2
5894–0516	183.0	3	3	12.6	5892–0816	102.0	3	3	9.2
5894–0519	175.0	3	3	14.2	5892–0817	104.5	5	4	9.6
5894–0520	176.5	3	3	18.2	5892–0819	101.0	3	3	8.9
5894–0521	179.0	3	3	15.3	5892.0820	107.0	4	4	8.6
5894–0523	177.5	3	3	13.5	5892–0841	110.5	6	5	11.4
5894–0524	175.0	5	3	15.4	5892–0844	108.0	3	3	9.4
5894–0526	173.0	3	3	19.2	5892–0845	103.0	3	3	11.0
5894–0528	178.5	3	3	17.1	5892–0846	106.0	3	3	9.9
5894–0529	159.0	5	5	25.0	5891–0100	43.0	3	3	8.6
5894–0530	172.5	4	4	18.4	5891–0104	129.5	2	2	7.4
5894–0531	155.5	4	4	14.5	5891–0112	135.6	5	5	8.7
5894–0532	170.5	4	4	22.4	5891–0116	122.0	3	3	10.6
5894–0533	169.5	4	4	24.1	5891–0121	133.0	10	10	17.2
5894–0534	178.0	3	3	17.5	5891–0124	137.5	4	4	12.0
5894–0535	170.5	3	3	15.6	5891–0126	———	4	4	8.6
5894–0537	165.0	2	2	12.6	5891–0127	139.5	7	6	16.0
5894–0538	164.5	4	4	18.8	5891–0131	146.5	6	6	10.0
5894–0540	181.3	3	3	16.4	5891–0133	149.0	7	6	11.4
5894–0542	182.0	3	3	15.1	5891–0135	151.5	10	10	21.2
5894–0543	171.0	3	3	13.5	5891–0136	139.5	4	4	8.2
5894–0544	185.0	2	2	15.6					

TABLE II.—GROWTH OF SEEDLINGS AT 27 DAYS OLD, CLASSIFIED ACCORDING TO HEIGHT AND FREQUENCIES UNDER EACH.

Height in cm.	College number					
	5893	*5894*	*5895*	*5896*	*5892*	*5891*
30.5						1
31.5						1
32.5						
33.5						1
34.5	1					1
35.5						1
36.5						
37.5					1	1
38.5					1	1
39.5		1	5			
40.5			3			1
41.5	2	4	1		1	1
42.5		1	1	1	1	2
43.5		1	3			1
44.5	2	5	1	1	1	
45.5	2	8	4	1		
46.5	2	2	7	1	4	
47.5	3	4	4	1	1	
48.5	5	3	1	3		
49.5	2	1	4	1	1	
50.5	6	2		1	1	
51.5	3	1	1	2		
52.5	3	3	3	2	1	
53.5	1	1	1	2	1	
54.5	1	1	1	2	3	
55.5	1	1	1		2	
56.5	2			3		
57.5	2					
58.5	1			1		
59.5				1	1	
60.5				1		
61.5				1		
62.5				1		
63.5				1		

TEST-ROW RESULTS

The time of maturity of the test rows was recorded. After this the whole test row was harvested with the roots, was tied in bundles with the stake bearing its number and was brought to the laboratory. Here the plants were cured for several days. The progeny of each parent plant was spread on the floor for examination as to uniformity, since this character was impossible to see clearly in the field on account of the distance between the rows and lodging habit of some of the varieties. When the plants of each test row were uniform or fairly uniform, and were prolific, 3 to 5 of the best plants (elites) were separated. The culm length, number of culms, and number of bearing culms were recorded for every plant. The losses due to the ravages of disease, insects, and birds, and those due to shattering were accurately determined for every row, in order to find the percentage of loss due to these causes combined. Without this, the average performances of each test row is not fully accounted for, because the ravages of diseases and pests cannot be uniform for all the rows. The average performance of each plant for every test row was taken, since this is the only basis for judgment of the value of a test row. These data appear in Table III.

Tables I and III should not be directly compared because the first is made up of the selections from farmers' fields, where the treatment, soil and climatic conditions are different from those of the breeding plot.

Not all the important characters of the rice plant appear in these tables. This is because this work is based primarily upon production and also because the writer follows Dr. H. Hjalmar Nilsson (5) when he says: The only true starting-point for the fixation of different types must be plants taken one by one; the only unity with which we should work must be the living plant itself and not at all—as had hitherto been supposed—its individual organs: the ear, the grain, etc., to which different hereditary disposition had been attributed.

TABLE III.—SHOWING PERFORMANCE AND THE POTENTIAL POSSIBILITIES OF THE TEST ROWS

Row Number	Average Length of culm in centimeters	Average total No. of culms	Average No. bearing culms	No. of days, sowing to maturity	Condition of test Row	No. of plants in Row	Yield of Row in grams	Average actual weight of caryopses	Per cent lost	Total average weight in grams	Calculated yield Ha. Test Rows in Kg.	Calculated yield Ha. Rows in Cav.	Calculated yield Ha. Gen. Stock in Cav.	Gain over Gen. Stock in Cav.
Ganado 5893F$_1$														
–0401	162.0	6.8	6.0	208	fu	21	284.2	13.5+	25	16.9	3380	76.9	50.2	26.7
–0402	162.4	3.2	3.0	207	nu	19	148.7	7.8+	37	10.7	2140	49.7	50.2	–0.5
–0403	150.0	6.0	5.2	207	u	26	358.5	13.8—	24	17.1	3420	79.5	"	29.3
–0405	159.0	6.4	5.6	211	u	25	531.1	21.2+	9	23.1	4620	107.4	"	57.2
–0407	145.4	5.2	3.7	208	nu	22	170.0	7.7+	42	10.9	2180	50.7	"	0.5
–0408	151.0	5.0	4.0	208	nu	15	190.7	12.7+	29	16.4	3280	76.3	"	26.1
–0409	134.3	6.8	5.8	207	fu	19	278.6	14.7—	26	18.5	3700	86.0	"	35.8
–0412	138.0	5.0	4.0	207	nu	23	201.0	8.7+	16	10.1	2020	47.0	"	–3.2
–0413	162.2	5.8	5.1	208	fu	23	333.8	14.5+	31	19.0	3800	88.4	"	38.2
–0414	162.0	7.4	6.4	207	fu	23	309.3	13.4+	24	16.6	3320	77.2	"	27.0
–0415	157.4	5.8	5.0	210	fu	26	237.5	9.1+	29	11.7	2340	54.4	"	4.2
–0416	157.2	6.0	5.2	207	fu	26	400.8	15.4+	16	17.9	3580	83.2	"	33.0
–0417	163.9	5.1	4.3	207	nu	25	246.3	9.9—	26	12.5	2500	58.1	"	7.9
–0418	157.7	7.0	5.0	208	fu	29	268.9	9.3+	24	11.5	2300	53.5	"	3.3
–0419	175.5	6.7	6.1	207	fu	20	295.0	14.8—	32	19.5	3900	90.7	"	40.5
–0420	166.6	6.4	4.7	207	fu	23	241.3	10.5—	40	14.7	2940	68.4	"	18.2
–0421	168.0	6.0	5.0	208	fu	21	209.1	9.9+	35	13.4	2680	53.3	"	12.1
–0424	158.0	4.0	4.0	207	nu	24	136.0	5.7—	28	7.3	1460	34.0	"	–16.2
–0426	154.0	5.4	4.4	210	nu	17	160.3	9.4+	37	12.9	2580	60.0	"	9.8
–0427	163.7	7.4	6.0	207	fu	22	265.5	12.1—	41	17.0	3400	79.0	"	28.8
–0428	175.0	6.0	5.2	207	fu	21	242.3	11.5+	52	17.5	3540	82.3	"	32.1
–0429	159.1	5.3	4.1	210	nu	24	204.2	8.5+	34	11.4	2280	53.0	"	2.8
–0431	160.0	5.4	4.0	210	nu	22	175.6	8.0+	41	11.3	2260	52.5	"	2.3
–0433	170.0	6.2	4.4	210	fu	19	225.8	11.9—	31	15.5	3100	73.0	"	22.8
–0434	149.0	5.0	3.7	210	nu	23	240.5	6.1+	24	7.6	1520	53.3	"	–14.9
–0435	162.0	6.0	4.4	211	fu	27	238.4	8.8+	42	12.5	2500	58.1	"	7.9
–0438	165.6	5.1	4.0	207	nu	19	213.9	11.3—	37	14.4	2880	67.0	"	16.8
–0439	155.5	5.7	5.3	207	nu	17	187.0	11.0	37	15.0	3000	69.7	"	19.5
–0446	171.6	6.3	5.0	210	fu	24	328.8	13.7—	24	16.9	3380	78.6	"	28.4
–0449				210	fu	20	253.0	12.2—	36	16.8	3360	78.1	"	27.9
–0456	168.0	7.0	5.5	207	fu	12	174.0	14.5	37	19.9	3980	92.5	"	42.3
–0471	184.0	6.3	5.3	207	fu	19	255.9	13.5—	35	18.2	3640	84.6	"	34.4
–0477	155.7	5.8	4.5	207	nu	21	231.1	11.0+	31	14.4	2880	67.0	"	16.8
–0478	165.3	5.3	4.6	207	fu	19	310.0	16.3+	37	22.3	4460	103.7	"	53.5
–0480	192.4	5.3	4.0	210	fu	23	310.0	13.5—	37	18.4	3680	85.6	"	35.4
–0486	169.6	5.6	4.8	208	nu	16	193.9	12.1+	27	15.4	3080	71.6	"	21.4
–0487	177.8	6.0	5.6	208	fu	19	309.6	16.3—	36	22.1	4420	102.8	"	52.6
–0489	155.0	5.0	4.0	208	nu	20	138.5	6.9+	9	7.5	1500	34.8	"	–15.4
–0490	161.7	6.4	5.2	210	fu	19	327.4	17.2+	32	22.7	4540	105.5	"	55.3
Iroy 5894F$_1$														
–0500	164.2	5.3	5.3	210	u	19	238.0	12.5+	4	13.0	2600	60.4	59.1	1.3
–0501	160.9	6.3	6.1	210	nu	15	167.0	11.1+	18	13.1	2620	60.9	"	1.8
–0502	160.1	7.6	6.5	210	u	20	271.8	13.6—	26	17.1	3420	79.5	"	20.4
–0503	144.6	5.3	4.2	210	nu	23	130.0	5.7—	33	7.5	1500	34.8	"	—24.3
–0503	177.4	6.1	5.7	211	u	29	361.7	12.5—	11	13.8	2760	64.2	"	5.1
–0507	164.3	5.3	5.0	211	u	16			18					
–0509	169.1	5.6	4.9	211	fu	22	256.0	11.6+	18	13.7	2740	63.7	"	4.6
–0510	167.5	7.7	6.2	211	u	21	332.0	15.8+	30	20.5	4100	95.3	"	36.2
–0511	181.3	7.9	6.4	210	u	26	461.7	17.8—	20	21.3	4260	99.0	"	39.9
–0512	171.2	7.3	6.7	211	u	24	497.5	20.7+	18	24.4	4880	113.5	"	54.4
–0514	168.9	7.9	6.9	210	u	22	507.0	23.0+	24	28.5	5700	132.5	"	73.4
–0515	147.8	6.6	6.2	209	u	26	473.1	18.2—	13	20.5	4100	95.3	"	36.2
–0516	171.4	7.6	6.5	211	fu	19	339.3	17.9—	12	20.0	4000	93.0	"	33.9
–0519	163.4	8.3	7.3	211	u	19	481.7	25.4—	16	29.4	5880	136.7	"	77.6

NOTE:

u—uniform progeny.
fu—fairly uniform progeny.
nu—non-uniform progeny.

TABLE III.—SHOWING PERFORMANCE AND THE POTENTIAL POSSIBILITIES OF THE TEST ROWS—*Continued.*

Row Number	*Average Length of culm in centimeter*	*Average total No. of culms*	*Average No. bearing culms*	*No. of days sowing to maturity*	*Condition of test Row*	*No. of plants in Row*	*Yield of Row in grams*	*Average actual weight of caryopses*	*Per cent lost*	*Total average weight in grams*	*Calculated yield Ha. Test Rows in Kg.*	*Rows in Cav.*	*in Cav. Gen. Stock*	*Gain over Gen. Stock in Cav.*
–0520	155.0	6.6	6.4	210	u	27	635.4	23.6—	11	26.1	5220	121.4	"	62.3
–0521	166.3	7.3	6.3	211	u	20	417.5	20.9	20	25.0	5000	116.2	"	57.1
–0523	163.8	6.8	6.0	210	fu	16	324.4	20.4—	12	22.8	4560	106.0	"	46.9
–0524	163.6	6.2	5.5	210	fu	17	350.9	20.6+	15	23.7	4740	110.2	"	51.1
–0526	163.0	7.7	6.8	210	u	23	523.3	22.7+	18	26.7	5640	131.1	"	72.0
–0528	173.6	6.9	6.4	210	fu	19	376.9	19.8	8	21.4	4280	99.5	"	40.4
–0529	168.1	6.3	5.1	210	u	23	417.9	18.2—	16	21.1	4220	98.1	"	39.0
–0530	176.3	1.1	9.0	210	u	19	455.2	23.9—	11	26.5	5300	123.2	"	64.1
–0531	183.7	6.3	5.2	211	fu	12	242.4	20.2—	6	21.4	4280	99.5	"	40.4
–0532	161.5	4.8	4.6	211	fu	13	191.0	14.7—	11	16.3	3260	75.8	"	16.7
–0533	154.0	7.4	6.1	210	nu	20	521.0	26.1	17	30.5	6100	141.8	"	82.7
–0534	151.8	7.1	5.6	211	fu	16	280.3	17.5+	6	18.5	3700	86.6	"	26.9
–0535	151.8	5.2	4.4	210	nu	10	99.0	9.9	6	10.5	2100	48.8	"	—10.3
–0537	159.9	6.9	5.4	210	u	10	235.4	23.5	19	28.0	5600	130.2	"	71.5
–0538	164.4	6.5	5.9	211	fu	13	254.0	19.5+	18	23.0	4600	106.9	"	47.8
–0540	169.6	5.7	5.2	211	fu	13	340.8	18.5+	9	20.2	4040	93.9	"	34.8
–0542	168.9	6.6	6.4		fu	7	164.1	23.4	14	26.7	5340	124.2	"	65.1
–0543	166.4	6.3	6.2	210	fu	10	198.3	19.8+	16	22.0	4400	102.3	"	43.2
–0544	175.4	7.2	5.8	210	fu	12	251.4	20.9+	4	21.7	4240	98.6	"	39.5
–0545	156.9	7.7	7.1		fu	7	193.0	27.6—	11	30.6	6120	142.3	"	83.2
–0546	172.1	7.8	6.0	210	fu	10	276.4	27.6+	18	32.6	6520	151.6	"	92.5
–0554	161.8	5.2	0.0	210	fu	13	241.3	18.6—	19	22.1	4420	102.8	"	43.7
–0555	159.0	5.0	4.9	210	fu	13	212.4	16.4+	3	16.9	3380	78.6	"	19.5
–0563	159.0	4.9	4.5	210	fu	8	146.6	18.3	5	19.2	3840	89.3	"	30.2
–0570	177.8	7.3	5.7	210	fu	13	272.7	21.0—	16	24.3	4860	113.0	"	53.2
–0571	152.1	5.0	4.9	210	fu	10	160.7	16.0	20	19.2	3840	88.3	"	30.9
Binalayan $5895F_1$														
–0602	145.9	4.7	4.7	207	fu	23	304.6	13.2+	19	15.7	3140	73.0	51.1	21.9
–0603				203	u	32	528.6	16.5	26	20.8	4160	96.7	"	45.6
–0607	156.6	4.6	4.4	205	fu	25	350.9	14.0	7	15.0	4160	69.7	"	18.6
–0609	145.7	4.8	4.5	206	nu	28	491.8	17.5	13	19.8	3960	92.1	"	41.0
–0612	151.1	5.8	5.4	205	fu	16	453.7	18.9+	16	21.9	4380	101.8	"	60.7
–0614	154.2	3.8	3.4	206	nu	25	297.6	11.9	22	14.5	2900	67.4	"	26.3
–0615	169.2	5.7	5.2	205	u	25	497.2	19.9—	9	21.6	4320	100.4	"	49.3
–0617	185.7	5.3	5.2	205	fu	23	507.7	22.1—	10	24.3	4860	113.0	"	61.9
–0618	169.7	5.2	4.7	205	u	27	604.5	22.4—	10	24.6	4920	114.4	"	63.3
–0619	162.5	4.6	4.4	205	fu	28	508.1	18.1+	2	18.5	3700	86.0	"	34.9
–0620	149.6	4.3	4.1	205	nu	20	270.6	13.5+	5	14.2	2840	66.0	"	14.9
–0621	165.6	6.3	5.9	208	u	20	414.5	20.7	14	23.6	4720	109.7	"	58.6
–0622	161.2	5.6	5.4	203	nu	24	367.8	14.1+	11	15.7	3140	73.0	"	21.9
–0624	152.7	4.9	4.8	205	fu	23	359.4	15.6—	15	17.9	3580	83.2	"	32.1
–0625	166.3	5.5	5.1	205	u	25	560.0	22.4	5	23.5	4600	106.9	"	55.8
–0626	158.5	5.5	5.2	206	fu	24	429.8	17.9—	3	18.4	3680	85.6	"	34.5
–0627	152.5	3.5	3.4	206	nu	19	249.9	13.2—	16	15.3	3060	71.7	"	20.6
–0630	145.3	6.9	6.2	205	fu	23	400.6	17.4+	6	18.4	3680	85.6	"	34.5
–0631	149.3	4.5	4.4	208	fu	22	329.2	15.0	14	17.1	3420	79.5	"	28.4
–0632	160.9	4.4	4.3	208	fu	19	97.9	5.1+	18	6.0	1200	27.9	"	—23.2
–0633	169.8	6.8	6.2	208	u	18	458.1	25.5—	5	26.7	5340	124.2	"	73.1
–0635	147.0	4.8	4.3	205	fu	16	230.4	14.4	23	17.7	3540	82.3	"	31.2
–0636	162.5	5.7	5.2	206	nu	22	470.0	21.4—	6	22.6	4520	105.1	"	54.0
–0637	148.1	4.5	4.0	205	fu	20	343.5	17.2—	18	20.2	4040	93.9	"	42.8
–0638	155.4	5.5	5.2	208	fu	20	319.0	16.0—	10	17.6	3540	82.3	"	31.2
–0639	161.4	5.6	5.2	205	fu	20	347.3	17.4—	7	18.6	3720	86.5	"	35.4
–0640	171.4	5.1	4.9	208	fu	23	424.7	18.4	11	20.4	4080	94.0	"	42.9
–0641	165.6	5.3	5.0	205	u	22	434.0	19.7	15	22.7	4540	105.6	"	54.5
–0642	161.7	4.8	4.5	208	fu	21	393.5	18.7+	5	19.6	3920	91.1	"	40.0

NOTE:

u—uniform progeny.
fu—fairly uniform progeny.
nu—non-uniform progeny.

TABLE III.—SHOWING PERFORMANCE AND THE POTENTIAL POSSIBILITIES OF THE TEST ROWS—*Continued.*

Row Number	*Average Length of culm in centimeter*	*Average total No. of culms*	*Average No. bearing culms*	*No. of days sowing to maturity*	*Condition of test Row*	*No. of plants in Row*	*Yield of Row in grams*	*Average actual weight of caryopses*	*Per cent lost*	*Total average weight in grams*	*Calculated yield Ha. Test Rows in Kg.*	*Test Rows in Cav.*	*Gen. Stock in Cav.*	*Gain over Gen. Stock in Cav.*
-0643	755.8	4.6	4.2	205	fu	24	389.3	16.2+	12	18.1	3620	84.2	"	33.1
-0644	142.2	4.9	4.3	208	nu	21	185.2	8.8	13	9.9	1980	46.0	"	— 5.1
-0646	162.9	4.5	4.3	208	u	18	261.3	14.5	12	10.0	3240	75.3	"	24.2
-0647	154.8	5.7	4.7	205	fu	23	222.8	9.7—	11	10.7	2540	49.7	"	— 1.4
-0648				208	fu	14	225.0	16.1+	12	18.0	3600	83.7	"	32.6
-0650	154.9	4.8	4.1	205	nu	26	335.4	12.9	17	15.1	3020	70.2	"	19.1
-0655	144.2	7.1	6.6	205	u	19	276.5	14.6—	23	17.9	3580	83.2	"	32.1
-0663				206	nu	18	141.0	7.8+	9	8.5	1700	39.5	"	—11.6
-0680	155.3	5.4	4.7	208	fu	23	372.1	16.2	5	17.0	3400	79.0	"	27.9
-0687				206	nu	24	203.5	9.5—	9	10.3	2060	47.9	"	— 3.2
-0695	161.8	5.1	5.0	204	fu	26	437.5	16.6—	9	18.0	3600	83.7	"	32.6
Dequet á Bolilising														
5896F$_1$														
-0700	164.3	5.0	4.6	200	fu	16	124.2	7.7+	25	9.6	1920	44.6	34.3	10.2
-0701	177.9	6.7	5.7	200	fu	25	228.6	9.1+	20	10.9	2180	50.7	34.4	16.3
-0702	177.7	6.0	5.0	199	fu	22	185.2	8.4+	29	10.8	2160	50.2	"	15.8
-0703	177.3	6.7	5.8	197	fu	20	171.1	8.6—	33	11.4	2280	53.0	"	18.6
-0704	179.0	6.0	4.5	197	nu	20	105.7	5.3—	23	6.5	1300	30.2	"	4.2
-0705	174.5	6.7	5.8	200	fu	23	229.5	10.0—	45	14.5	2900	65.1	"	26.7
-0706	183.0	7.0	6.6	200	nu	15	99.3	6.6+	57	10.4	2080	48.4	"	14.0
-0708	188.0	7.6	6.6	200	fu	10	53.3	5.3	57	8.3	1660	38.6	"	4.2
-0711	177.0	5.7	4.8	200	fu	12	21.0	1.7	93	3.3	640	15.3	"	—19.1
-0712	189.0	6.5	6.0	200	fu	11	55.6	5.1—	47	7.4	1480	34.4	"	0.0
-0713	183.6	6.0	5.6	197	fu	23	103.3	4.3	92	8.3	1660	38.6	"	4.2
-0714	185.3	5.5	4.7	201	nu	18	71.3	4.0—	31	5.2	1040	23.7	"	10.7
-0716	182.0	5.6	5	206	fu	13	148.9	11.5—	17	13.4	2680	62.3	"	27.9
-0717	186.8	6.0	5.6	197	fu				31					
-0718	170.0	5.5	5.0	201	fu	8	61.0	7.6	37	10.4	2080	48.3	"	13.9
-0719	186.6	7.0	6.6	201	fu	17	145.7	8.6—	43	12.2	2440	56.7	"	22.3
-0722	185.0	5.2	5.0	201	fu	20	92.5	4.6	20	5.5	1100	25.6	"	— 8.8
-0723	179.0	6.0	5.0	201	nu	10	60	6.0	61	9.6	1920	44.6	"	10.2
-0726	181.5	7.3	6.2	197	nu	13	134.4	10.3+	34	13.8	2760	64.2	"	29.8
-7288	181.5	5.6	5.0	197	fu									
-0731	192.0	8.0	7.0	201	fu	15	140.0	9.3+	35	12.6	2520	58.6	"	24.2
-0734	191.0	7.0	7.0	201	nu	14	37	2.6+	44	3.7	740	17.2	"	—17.2
-0738	177.0	6.6	6.0	201	fu				25					
-0741	183.0	6.0	5.4	201	u	22	122.1	5.5—	28	7.0	1400	32.5	"	— 1.7
-0754	178.0	7.3	6.1	201	fu	16	258.5	16.2—	25	20.2	4040	93.9	"	59.5
Binangbang														
5892F$_1$														
-0800				213	fu	29	332.0	11.4	16	13.2	2640	61.4	41.8	19.6
-0801	126.4	6.0	5.7	213	fu	28	224.0	8.0	17	9.4	1880	43.7	41.8	1.9
-0802	141.0	6.2	6.0	213	fu	30	251.3	8.4—	19	9.9	1980	46.0	"	4.2
-0803														
-0804	136.0	7.6	7.2	215	nu	28	241.9	8.6+	20	10.3	2060	47.9	"	6.1
-0805														
-8060	140.0	8.4	8.4	215		30	236.0	7.9—	29	10.1	2020	46.9	"	5.1
-0807	131.0	6.0	6.0	215	fu	26	281.0	10.8+	11	12.0	2400	55.8	"	14.0
-0808	143.3	6.3	6.2	215	u	30	302.0	10.0+	19	11.9	2380	55.3	"	13.5
-0809	133.4	6.1	5.8	215	u	31	427.0	13.8—	19	16.4	3280	76.2	"	34.4
-0810														
-0811	127.0	6.0	6.0	215	u	32	401.8	12.6—	8	13.6	2720	63.2	"	21.4
-0812	134.0	6.6	6.0	214	fu	25	220.4	8.8+	17	10.3	2060	47.9	"	6.1
-0816	136.1	8.7	8.5	214	fu	29	680.1	23.5+	7	25.1	5020	116.7	"	75.0
-0817	130.0	7.8	7.2	214	fu	28	322.0	11.5	6	12.2	2440	56.7	"	14.9

NOTE:
u—uniform progeny.
fu—fairly uniform progeny.
nu—non-uniform progeny.

TABLE III.—SHOWING PERFORMANCE AND THE POTENTIAL POSSIBILITIES OF THE TEST ROWS.—*Continued.*

Row Number	*Average Length of culm in centimeter*	*Average total No. of culms*	*Average No. bearing culms*	*No. of days sowing to maturity*	*Condition of test Row*	*No. of plants in Row*	*Yield of Row in grams*	*Average actual weight of cray-opses*	*Per cent lost*	*Total average weight in grams*	*Calculated yield Ha. Test Rows in Kg.*	*Test Rows in Cav.*	*Gen. Stock in Cav.*	*Gain over Gen. Stock in Cav.*
–0819	133.0	8.0	7.4	211	fu	31	439.6	14.2—	11	15.7	3140	73.0	"	31.2
–0820	147.4	7.0	6.0	211	fu	32	466.0	14.6—	14	16.6	3320	77.2	"	35.4
–0841	134.0	7.0	7.0	211	fu	31	410.0	13.2+	10	14.5	2900	67.4	"	25.6
–0844	140.0	8.6	8.0	213	fu	31	614.9	19.8	2	20.2	4040	93.9	"	52.1
–8045	130.0	7.2	7.2	211	u	32	452.4	14.1	12	15.8	3160	73.5	"	31.7
–0846	133.0	10.0	9.6	211	u	30	607.6	20.3—	28	25.9	5180	118.1	"	76.3
Binicol 5891F$_1$														
–0100	113.7	3.1	3.1	134	fu	25	183.8	7.4—	31	9.6	1920	44.6	27.4	17.2
–0104	105.6	3.1	2.8	134	fu	9	48.2	5.4—	47	7.9	1580	36.7	"	9.3
–0112	112.8	4.0	4.0	134	u	20	163.8	8.2—	37	11.3	2260	52.5	"	25.1
–0116	114.9	3.8	3.5	133	fu	28	137.2	4.9	64	8.0	1600	37.2	"	9.8
–0121	117.8	3.9	3.9	136	fu	28	231.7	8.2—	26	10.4	2080	48.3	"	20.9
–0124	114.7	3.3	3.2	135	fu	23	127.6	5.5+	22	6.7	1340	31.1	"	3.7
–0126	137.0	3.4	3.4	135	fu	21	155.0	7.4—	44	10.6	2120	49.3	"	21.9
–0127	111.2	3.6	3.4	133	fu	24	128.4	5.4—	32	7.1	1420	33.0	"	5.6
–0131	118.4	5.1	3.7	133	nu	29	164.5	6.0+	35	8.1	1620	37.6	"	10.2
–0133	111.2	3.8	3.2	133	fu	25	117.3	4.7—	37	6.4	1280	29.7	"	2.3
–0135	111.9	2.7	2.7	133	fu	17	63.7	3.7+	55	5.7	1140	26.5	"	—0.9
–0136	111.7	3.5	3.4	133	fu	26	133.1	5.1+	43	7.3	1460	33.9	"	6.5

NOTE:
u—uniform progeny.
fu—fairly uniform progeny.
nu—non-uniform progeny.

Examination of Table III shows the following:

The individual test rows for every variety vary in average culm lengths, but this character bears no relation to production, as some test rows with average low culm lengths are as productive as those having long culms.

The greater the average number of bearing culms, the higher the production; that is, tillering to a certain extent correlates with production.

The number of days from sowing to maturity for every variety does not vary very widely for these selections, except in the case, of Variety 5896, Dequet a Bolilising. This is because selections were made several days before harvest.

The percentages of uniform, fairly uniform and non-uniform test rows for every variety may be made from the table.

	Uniform	*Fairly Uniform*	*Non-uniform*
5893F$_1$ Ganado	5.1	56.4	38.5
5894F$_1$ Iroy	40.0	50.0	10.0
5895F$_1$ Binalayan	22.5	52.5	25.0
5896F$_1$ Dequet á Bolilising	4.0	72.0	24.0
5892F$_1$ Binangbang	29.4	64.7	5.9
5891F$_1$ Binicol	9.1	81.8	9.1

In breading plants, it is absolutely impossible to get the test rows very uniform on account of the differences in the soil and the physiological reactions of the individual plants; the breeder should be satisfied if he gets the progeny of selected plants fairly uniform. As may be seen from the above the results came up to expectation, since the average percentage of uniform and fairly uniform test rows for the six varieties is 81, while that of the non-uniform test rows is only 19. Variety 5893F1 Ganado, has the highest per cent of non-uniform test rows. The test rows that are uniform and fairly uniform have high average yields, whereas the non-uniform test rows have very poor yields. The table reveals the rather

striking fact that almost all of the non-uniform test rows produced yields below the average of the unselected stock! Thus, uniformity is concomitant of high production, while the reverse is also true. See PlateI.

On account of the small size and irregular shape of the paddies, there is a variation in number of plants per row. Better and more accurate results might have been obtained had the length of the rows been even and had each contained about 100 plants.

Of greater practical importance, however, is the average yield per plant. In this important quality the test-row results show a very wide and marked variation. To take an example, the variation in 5894F1 Iroy was from 7.5 grams per plant for No. 5894F1—0503 to 32.6 grams per plant for No. 5894F1 —0546. The test rows show conclusively that the ability to produce well (prolificacy) is a highly individualistic character.

The percentages of loss within each variety and among the varieties differ very markedly. This is because the ravages of diseases and pests are not uniformly distributed even within the confines of one paddy. Also, lodging and easy shattering are conducive to a greater or less loss in the field. Inspection of the table shows that 5891F1 Binicol and 5895F1 Dequet à Bolilising suffered the greater losses—sometimes fully one-half of the crop. With Binicol, this was due mainly to birds and easy shattering. With Dequet a Bolilising this was due to rats which preferred this glutinous variety to the others.

The yields per hectare are gotten by mere computations, there yet being no actual extensive cultures of the individual selections. These computations are, however, very important for comparison of possibilities. Taking the spacing used in this work, 25 centimeters by 20 centimeters, there would be 200,000 plants in a hectare. The average production per plant multiplied by this figure gives the yield in kilograms. The product was divided by 43 in order to reduce it to cavans. The results are conservative, because as a matter of fact, the maximum production cannot be obtained by planting only one seedling to the hill. In actual farm practice 2 to 4 seedlings can be set to advantage in a hill with the same spacing. By giving the same spacing and using one seedling to the hill with the general stock, the yields are lower than what can normally be obtained for 5894 Iroy, 5895 Binalayan and 5893 Ganado. This is a proof of the claim made that maximum production cannot be obtained by using only one seedling to the hill.

FURTHER RIGID SELECTION

After the isolation of the strains having the desired qualities, further selection should be practiced on them, so that they will not deteriorate. This rigid selection should be made continuously from year to year. Individual plants that show better than the average for the test row (elites) should be selected with their characters recorded. These should be planted again in test rows, while the seeds of the remaining plants of the selected test rows should be rapidly multiplied. Table IV shows the elites with their important characteristics, selected from the test rows that have given the best performance.

NATURAL HYBRIDIZATION

While hybridization is not a part of this work, a passing mention of it is included because of the presence of a natural hybrid in the cultures. While studying the endosperm and grain texture of the selected plants it was observed that the seed of one plant had a cuticle of varying red color. This particular plant happened to be 5892-0808 Binangbang. The Laguna farmers cultivate both the Red Binangbang and the White Binangbang. Out of curiosity this number was cultured with the rest. The test-row result showed that it is a natural hybrid. In the row there were found white, light red, and red and the number of plants under each color as follows:

White	13
Light red	5
Red	12

TABLE IV.—ELITES FROM THE MOST PRODUCTIVE TEST ROWS SHOWING SOME OF THEIR CHARACTERISTICS

Elite No	*Length of culm in cm.*	*Total No. of culms*	*No. of bearing culms*	*No. of days sowing to maturity*	*No. of caryopses*	*Wt. of caryopses in grams*	*Av. yield for test row in grams*
5893F_1							
–0405A	177	13	13	211	1604	49.4	23.1
–0405B	171	7	7	211	1001	33.2	23.1
–0405C	166	8	8	211	805	30.0	23.1
–0405D	169	8	8	211	872	29.0	23.1
–0405E	170	10	10	211	977	28.5	23.1
–0409A	142	10	9	207	1291	38.1	18.5
–0409B	155	10	7	207	1161	35.0	18.5
–0409C	155	7	7	207	646	25.3	18.5
–0409D	148	9	8	207	538	22.0	18.5
–0413A	190	12	12	208	1325	50.2	19.0
–0413B	169	8	8	208	1162	28.8	19.0
–0413C	185	7	7	208	682	21.0	19.0
–0413D	180	6	4	208	602	20.5	19.0
–0419A	175	10	10	207	1063	31.5	19.5
–0419B	172	9	9	207	735	24.5	19.5
–0419C	184	10	8	207	794	23.0	19.5
–0419D	172	7	6	207	760	22.5	19.5
–0487A	187	8	8	208	1029	31.4	22.1
–0487B	183	5	4	208	817	26.7	22.1
–0490A	198	8	6	208	804	26.5	22.7
–0490B	190	6	3	208	492	24.0	22.7
–5894F_1							
–0512A	169	12	11	211	2297	71.5	24.4
–0512B	169	7	7	211	1429	37.0	22.4
–0512C	170	8	8	211	1056	34.0	24.4
–0512D	150	7	6	211	926	26.0	24.4
–0514A	177	8	7	210	1127	41.6	28.5
–0514B	176	8	8	210	1085	35.7	28.5
–0514C	180	9	9	210	1256	34.7	28.5
–0514D	190	17	7	210	887	28.9	28.5
–0514E	179	7	7	210	862	28.9	28.5
–0519A	160	9	9	211	1403	45.6	29.4
–0519B	174	9	8	211	1292	40.3	29.4
–0519C	159	9	8	211	1271	35.8	29.4
–0519D	180	10	8	211	968	30.5	29.4
–0520A	167	9	9	210	1265	40.8	26.1
–0520B	175	11	11	210	1328	37.6	26.1
–0520C	177	9	9	210	1236	36.5	26.1
–0520D	162	7	6	210	1071	31.5	26.1
–0520E	180	9	9	210	1099	30.0	26.1
–0526A	169	7	6	210	1116	33.9	26.7
–0526B	180	10	8	210	905	28.9	26.7
–0526C	161	8	8	210	922	27.7	26.7
–0530A	176	12	11	210	1481	42.3	26.5
–0530B	188	14	14	210	1369	41.3	26.5
–0537A	190	9	8	210	1460	49.2	28.0
–0537B	180	10	9	210	1383	42.0	28
–0537C	170	8	8	210	1254	39.6	28
–0542A	167	7	7		1010	27.9	23.4
–0545A	179	12	12		1800	66.8	30.6
–0546A	184	9	8	210	1101	36.0	32.6
–0570A	189	9	9	210	1131	34.5	24.3
–0570B	185	10	7	210	936	31.0	24.3

TABLE IV.—ELITES FROM THE MOST PRODUCTIVE TEST ROWS SHOWING SOME OF THEIR CHARACTERISTICS.—*Continued.*

Elite No	*Length of culm in cm.*	*Total No. of culms*	*No. of bearing culms*	*No. of days sowing to maturity*	*No. of caryopses*	*Wt. of caryopses in grams*	*Av. yield for test row in grams*
5895F_1							
–0617A	163	8	8	205	1400	46.0	24.3
–0617B	167	11	11	205	952	31.4	24.3
–0617C	170	7	7	205	792	25.5	24.3
–0618A	172	11	11	205	1832	67.2	24.6
–0618B	183	5	5	205	632	25.0	24.6
–0621A	180	7	7	208	933	43.3	23.6
–0621B	184	6	6	208	1027	35.4	23.6
–0621C	168	7	6	208	901	30.5	23.6
–0625A	187	6	6	205	833	45.0	23.5
–0625B	173	8	8	205	1255	35.8	23.5
–0625C	171	9	8	205	947	35.4	23.5
–0625D	162	7	7	205	1048	35.2	23.5
–0625E	180	8	8	205	952	28.6	23.5
–0633A	172	12	11	208	1224	47.9	26.7
–0633B	179	7	7	208	1077	39.7	26.7
–0633C	169	6	6	208	1079	36.3	26.7
–0636A	177	10	10	206	1327	51.5	22.6
–0636B	178	10	7	206	283	41.2	22.6
–0636C	715	8	7	206	1073	40.7	22.6
–0636D	171	7	7	206	640	26.0	22.6
–0641A	172	7	7	205	844	29.5	22.7
–0641B	181	7	6	205	796	28.8	22.7
5892F_1							
–0809A	141	7	7	215	1216	28.0	16.4
–0809B	137	8	8	215	1100	24.5	16.4
–0809C	142	9	9	215	935	21.0	16.4
–0811A	136	8	8	215	893	27.4	3.6
–0811B	132	7	7	215	826	19.3	3.6
–0811C	130	6	6	215	631	19.0	3.6
–0819A	148	16	16	211	1332	41.2	15.7
–0819B	145	18	16	211	1581	38.7	15.7
–0819C	140	12	11	211	1223	28.4	15.7
–0820A	164	12	11	211	1270	29.9	16.6
–0820B	168	10	9	211	1343	28.2	16.6
–0829C	160	12	12	211	1175	27.2	16.6
–0820D	151	6	6	211	987	22.9	16.6
–0820E	162	9	8	211	898	21.5	16.6
–0841A	145	9	9	211	850	22.2	14.5
–0841B	145	8	8	211	734	20.7	14.5
–0844A	134	10	10	213	1162	31.4	19.6
–0844B	130	8	8	213	902	24.0	19.6
–0844C	145	9	8	213	923	23.6	19.6
–0844D	143	12	12	213	950	20.6	19.6
5892F_1							
–0845A	150	11	11	211		24.6	15.8
–0845B	141	8	8	211		23.0	15.8
–0845C	134	10	10	211		21.0	15.8
–0845D	129	10	8	211		19.8	15.8
–0846A	131	11	11	211	1749	44.2	20.3
–0846B	147	18	18	211	1657	40.5	20.3
–0846C	131	14	14	211	1500	34.5	20.3
–0846D	139	13	13		1204	29.4	20.3

TABLE IV.—ELITES FROM THE MOST PRODUCTIVE TEST ROWS SHOWING SOME OF THEIR CHARACTERISTICS.—*Continued.*

Elite No	*Length of culms in cm.*	*Total No. of culms*	*No. of bearing culms*	*No. of days sowing to maturity*	*No. of caryopses*	*Wt. of caryopses in grams*	*Av. Yield for test row in grams*
5896F_1							
–0703A	168	12	10	197	867	30.3	11.4
–0703B	185	8	7	197	657	24.0	11.4
–0703C	181	9	6	197	807	26.0	11.4
–0705A	178	10	8	200	1104	40.4	14.5
–0705B	176	15	13	200	1046	33.2	14.5
–0705C	178	5	5	200	630	23.2	14.5
–0726A	196	6	5	206	370	22.7	13.4
–0726B	184	7	7	206	629	20.6	13.4
–0726C	178	8	7	206		17.2	13.4
–0719A	188	9	9	201	687	22.0	12.2
–0719B	183	11	10	201	574	20.5	12.2
–0719C	172	14	10	201	511	18.0	12.2
–0726A	187	9	8	197	1127	37.7	13.8
–0726B	191	11	10	197	483	17.8	13.8
–0731A	193	16	13	201	1691	52.5	12.6
–0731B	184	12	12	201	1208	34.5	12.6
–0754A	190	15	13	201	2063	78.5	20.2
–0754B	188	10	10	201	638	22.5	20.2
–0745C	188	9	7	201	696	22.0	20.2
5891F_1							
–0112A	118	6	6	134	869	15.6	11.3
–0112B	111	6	6	134	756	15.0	11.3
–0112C	114	5	5	134	624	13.7	11.3
–0112D	120	4	4	134	572	13.7	11.3
–0112E	115	4	4	134	670	13.5	11.3
–0121A	123	4	4	136		16.4	10.3
–0121B	129	4	4	136		15.9	10.3
–0121C	128	5	5	136		14.5	10.3
–0126A	110	4	4	135	518	12.4	10.5
–0126B	120	4	4	135	510	12.2	10.5
–0126C	125	3	3	135	431	11.7	10.5
–0131A	125	7	7	133	808		10.5
–0131B	131	3	3	133	721		

This shows that the plant was heterozygous. Moreover, this chance hybrid shows that occasional crossing takes place in the field in spite of the highly self-pollenized condition of rice.

DISEASES AND PESTS

The season was very favorable for rice. In spite of this, the plants suffered from tip burn, a physiological disease which is caused by excessive heat. This is not serious.

A few young plants that were becoming yellow were collected and given to Mr. Simon Reyes, Assistant in Plant Pathology, for the laboratory determination of some causal organisms. He reported to the writer that neither he nor Mr. Reinking could find any fungus, and that the latter was inclined to believe that the disease was rather physiological.

The weather was favorable for fungus development as was the case in other rice fields and the tobacco cultures of the college. Mr. Roman Tomaneng, a student in Plant Pathology, and the writer walked around the paddies in search of fungus-attacked plants, but found only three plants of which the

heads were attacked by the rice smut, *Ustilagonoidea virens* Cke. et Tak. This freedom from fungus diseases was apparently due, at least in part, to the selection of plants that were free from them, since some other fields near by were seriously infected.

The rice bug, *Leptocorisa acuta* Thunb., did some mischief, but the damage wrought was insignificant. The rice-stem borer (a) did more damage than *Leptocorisa acuta* Thunb. especially on 5893 Ganado.

Rats did very considerable damage especially to the glutinous variety 5896 Dequet à Bolilising. A fair average performance of this variety could not be taken.

Birds (*mayas*) did the most damage. There is a widespread belief that bearded varieties are not attacked by birds. Observations on the cultures showed that they do damage to bearded rice, only that it is not as rapid a process as with non-bearded varieties.

CONCLUSIONS

1. It pays to select rice, since selected seed will easily double the ordinary yield of mixed sorts.

2. Of the six varieties studied, two Ilocano or bearded rices, Iroy and Binalayan, especially the former, are the most productive varieties and have the most prolific strains.

3. It is premature to state at present the value of the isolated strains. They should be rapidly multiplied and individual selection should be continued. They should be further tested from season to season and side by side with the farmer's stock in different localities before conclusions and seed distributions are made.

4. Since there is a great wealth of Philippine varieties and all Philippine work, so far, has merely scratched the surface, much more work of this kind should be done to include all conceivable types of rice, in order to determine the few which can be recommended to supplant unproductive and mixed sorts.

5. For the present there is no need of hybridization work, until the desirable qualities of standard rices are known and are fixed by selection; then well controlled hybridization, with the exact knowledge of the desirable characters of the varieties to be crossed can be made with some possibility of advantage.

RECOMMENDATIONS

1. Since at present the common farmer cannot be relied upon to protect his varieties from admixtures and much less to do his own selecting according to the foregoing method, on account of the time and work involved, the government or some private concern should provide pedigreed seed to the farmer. At this stage when cooperation is in its infancy the farmers collectively in a region cannot be expected to undertake this work. Following the successful examples of Java and Japan the government should do the work on a really *comprehensive scale* and for this purpose the establishment of a central experiment station is imperative. Among its duties, the improvement of rice culture throughout the Islands in all conceivable ways, and the determination of facts for the guidance of the practical breeder, should be given first attention. Correlated with it there should be established in the principal rice regions, such as Pangasinan, Nueva Ecija, Iloilo Capiz, Tarlac, etc., branch stations to carry out the further testing of the local strains, the distribution of pure seed, and the demonstration of best methods of culture.

2. A botanical synposis of all the standard rice varieties of the Philippines should be made as a guide for the breeder

(a) *Schoenobius incertellus* Wlk. Fam. Pyralidae.—ED.

in identifying the many locally-named varieties. A beginning in this work has already been made at the College of Agriculture.

ACKNOWLEDGMENTS

The writer expresses his obligation to Professor Charles F. Baker for his valuable suggestions during the progress of this investigation, and to Messrs. Matias Gonzalez and Manuel A. Gonzalez and their associates in the "Hacienda Esperanza" of Pangasinan for courtesies received.

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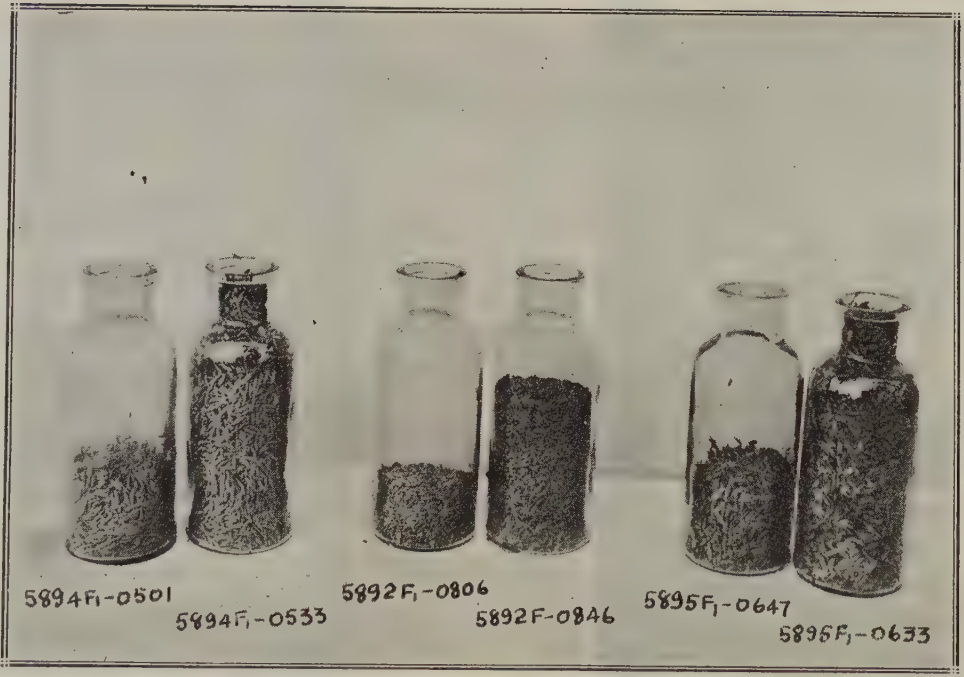
PLATE I.

UNIFORMITY, ONE OF THE CAUSES OF HIGH PRODUCTION
PROGENY OF SELECTED PARENT PLANT 5894-0515 IROY.
AVERAGE YIELD PER PLANT—20.5 GRAMS.

PLATE II.

NON-UNIFORMITY, ONE OF THE CAUSES OF LOW PRODUCTION
PROGENY OF SELECTED PARENT PLANT 5894-0503 IROY.
AVERAGE YIELD PER PLANT—7.5 GRAMS.

PLATE III.



COMPARATIVE YIELDS OF 6 PLANTS, THE PROGENY OF SELECTED PARENTS OF 3 VARIETIES. BY SEED SELECTION, THE YIELD CAN BE EASILY DOUBLED.

Performance of Selections of Best Local Upland Rices Under Fertilization

By Arsenio A. Goco

Thesis presented for graduation from the College of Agriculture, No. 84.

INTRODUCTION

The term "upland rice" is applied to those varieties of rice which grow in ordinary well drained fields during the rainy season. Such rice may be grown wherever corn and sugar cane are grown and on newly opened *caingin* lands.

In the cultivation of this kind of rice several factors which are primarily essential to the production of lowland rice can be dispensed with; the most notable among these being artificial water supply and carabao. Upland rice is suitable therefore for general extensive rice culture either on new land or in sugar-cane districts. Putting upland rice in rotation with sugar cane, as recommended by the Bureau of Agriculture in connection with the lowland rice, should be encouraged. The present supply of labor and the number of work animals need not be increased to introduce this rotation. The rotation would, instead, be of advantage as the distribution of labor throughout the year will be uniform, that is, from January to March sugar cane could be planted; March, legumes; June, rice; October, corn.

As a result of the earlier studies of Philippine rices by the Bureau of Agriculture, Mr. C. M. Conner showed in one of his plotted curves, published in *The Philippine Agricultural Review*, Volume II, p. 86,(1) that there were varieties of upland rice yielding much more than any lowland varieties tested. In this curve it is noted that the frequency in occurence of high-producing upland varieties was greater than high producing lowland varieties. For example, the frequency of lowland varieties producing 2,100 kilos is 14 while the upland varieties of the same productiveness is 23; that of the lowland variety which produces 2,600 kilos is 1, while that of the upland variety is 21. In the test, no lowland variety was able to produce over 3,000 kilos, while the upland varieties were able to produce even as high as 3,400 kilos; and the frequency of the highest producing varieties (3,400 kilos) was 11. These facts were not mentioned by the author but his curve shows them clearly.

Mr. C. Balangue's thesis, published in Volume V, No. 5, of The Philippine Agriculturist and Forester, shows that upland rice grown in the province of Laguna is more productive than the lowland rice.

His average shows that upland rice gives higher averages of production than lowland. For every 100 cavans produced in paddy, 171 cavans (A) are produced in dry field of the same area. The figures tend to prove that the lowland rice the Laguna farmers are raising is less productive than upland rice would be, while the production of the former entails more labor, time and expense.

The annual import of rice is still enormous (81,788,027 kilograms 1914; 175,541,402 kilograms, 1915; 183,016,248 kilograms 1916) in spite of the long, steady work of the Bureau of Agriculture toward the improvement of paddy rice production. The improvement of upland rice will bring into use vast areas of unirrigated land, especially those farm lots devoted to sugar cane and corn culture, for these usually lie

idle about every other year and in this way become a prolific source of weeds and weed seeds.

As this kind of rice is not commonly cultivated by our farmers at present, improved seeds of the best varieties can, from time to time, be gradually supplied by the Government in sufficient quantities to meet the increasing demand as people become educated to its use.

As a result of a series of experiments on these rice varieties in Hawaii, it has been found that upland rice can assimilate both nitrate and ammonium salts equally well.(7)

In the experiments of fertilization of lowland and upland rices carried out by Mr. C. Balangue, (2) it was found that horse manure alone doubles the yield of rice in some localities. Combinations of manure and ash also proved profitable. But one of the most important results of the experiment was that showing the very varied needs of different Philippine soil, which leads to the conclusion that the most generally applicable improvement in rice production must be looked for in seed selection.

As to the improvement of rice by selection, only lowland rice has previously received attention in the Philippines. Mr. H. O. Jacobson of the Bureau of Agriculture was able to isolate strains of lowland rice which yield 6,625 kilograms or 154 cavans (B) of rough rice per hectare. (8) In Java similar work has been done with a result of 6,611 kilos per hectare. (9) When we take into consideration that the average yield of this crop per hectare in 1910 was 8.56 cavans and in 1914 was 14.87 cavans, the production of such strains promises to revolutionize rice culture in the Philippines.

Improved lowland varieties alone can not be depended upon at present, as lowland rice needs carabao, and large quantities of water. Cattle and steam power can be used for the cultivation of upland rice, as is practiced in large sugar estates. Irrigation is not much needed by this rice, in periods attended by dry spells, since planting at greater distances gives enough space for cultivation with work animals.

The object of the present work was to study the performance of the progeny of the best individual plants found growing in native fields, in test rows and plots with different fertilizers recommended for upland rice.

MATERIALS

The Field:—The field used was a rectangle of 2,000 square meters. It had been planted to yams for one year, previous to the present experiment and this crop was in turn preceded by cassava.

The soil of this field is somewhat silty, as shown by the following table obtained by means of the simple practical "soil separate" method. One hundred grams of soil are shaken in a bottle and put aside for one minute. Then the liquid, together with the suspended soil, is poured into another bottle. The second bottle is laid aside for one hour and its liquid is poured into a third bottle. The liquid of the third bottle is poured off after eight hours. The three grades of sediment were dried and weighed.

Weight of sample	Sand	Silt	Clay	Suspended Material after eight hours
100 grams	46.7	42.3 g	6.4 g	4.6

The Fertilizers:—The fertilizers used were fresh wood ashes, well rotted horse manure (three times the amount recommended by Mr. Balangue), double superphosphate containing 42% P2 O5, sulphate of ammonia, containing 20% N, and potassium chloride, containing 30% K.

The following descriptions of the varieties used are based on 10 selected mother plants picked at random.

VARIETIES USED

Kinandang Pula:—This variety is very popular among the farmers, because of its good taste, high productiveness and non-shattering quality. It produces few culms but each panicle is heavily loaded. Thus, it is adapted to close planting. The rice is translucent and soft and somewhat glutinous when boiled.

The plant matures in 121 days. It is 144.3 centimeters high, having an average of 5.2 nodes; the leaf is non-catching 56.78 cm. long and 1.48 centimeters wide. The panicle is 18.9 centimeters long and close and averages 3 per plant; the grain is Mars-yellow, smooth, 7.28 millimeters long and 3.08 millimeters wide. A cavan weighs 50.73 kilograms. Average number of grains to a plant, 637.2, weight, 16.68 grams.

Pinursigue:—For new fields this variety is much used because of its free stooling habit and rapid growth, a decidedly advantageous characteristic in the way of smothering other grasses. The grains shatter easily and the whole plant is too weak to hold the head. The rice is red and hard when boiled.

The plant matures in one hundred twenty eight days. It is 137.2 centimeters high, with average of 4.7 bearing culms with 5.5 nodes; the leaf is catchy 59.9 centimeters long and 1.04 centimeters wide; the panicle is close with few grains. The grain is pale orange-yellow 7.93 centimeters long and 3.47 centimeters wide. A cavan weighs 42.44 kilograms. Average good grains, 468.

Inintiw:—This variety is the commonest in the fields of Los Baños, Laguna. It is quite popular because when broadcasted, the size of stools increases in proportion to ground space between plants. It grows fast enough to smother grasses. The plant is sufficiently strong to hold its head. The grains shatter moderately. The rice is of fair taste and translucent.

The plant matures in 121 days. It is 141.3 centimeters high with 3.2 bearing culms with 5.7 nodes; the leaf is catchy, 62 cm. long and 1.15 centimeters wide. The panicle is close with few grains. The grain is catchy, light orange-yellow 7.8 centimeters long and 3.23 centimeters wide. A cavan weighs 43.87 kilograms Average good grains per plant, 375.5, weighing 11.02 grams.

Kinamaleg:—Kinamaleg is a heavy-producing variety, but the grain is small. The stoolings are few but each panicle produces many grains. The grains do not shatter but they are easily threshed. The plants resist strong wind. The rice is translucent and one of the best in taste and in cooking quality.

The plant matures in 134 days. It is 135.2 centimeters high having 5.8 nodes; the leaf is smooth, 47.6 centimeters long and 1.61 centimeters wide. The panicle is close, 12.8 centimeters long, and averages 5.7 per plant. The grain is Mars-yellow, hairy, 6.07 millimeters long and 3.2 milimeters wide. A cavan weighs 45.95 kilograms. Average number of grains, 1048.8, weighing 16.1 grams.

Kinagaykay:—This is heavy-producing variety when planted closely. The rice is translucent and nearly approaches the ideal size. The grains do not shatter readily. The plant is strong enough to hold up the head and resist wind. The taste is good and the cooking quality is fair.

This variety matures in 128 days. It is 167.9 centimeters high having 5.9 nodes. The leaf is smooth; 54.9 centimeters long and 1.25 centimeters wide. The panicle is compact 26.4 centimeters long, and averages 2.3 per

plant. The grain is deep-chrome with Sudan-yellow stripes, smooth, 7.4 millimeters long and 2.59 millimeters wide. A cavan weighs 44.59 kilos. Average number of good grains, 487.5, weighing 10.573 grams.

Guluyang Pula:—This is a productive variety when planted closely. It is palatable and cooks well. The rice is translucent and medium in size. The grain does not shatter readily. The stalk is strong enough before maturity; but it becomes brittle when matured.

This variety matures in 128 days. It is 155 centimeters high; average number of nodes, 5.9. The leaf is smooth, 59.2 centimeters long and 1.62 centimeters wide. The panicle is close; 23.2 centimeters long, and averages 3.6 per plant. The grain is Mars-yellow, smooth, 6.2 millimeters long and 3.2 millimeters wide. A cavan weighs 51.85 kilograms.

WEATHER AND GROWTH

The rainfall during the growing season of the rice was fairly uniform. It rained nearly every day, the minimum weekly precipitation being 1.47 centimeters and the highest, 13.39. But due to the continuous wind during the middle part of August, the plants fertilized with commercial nitrogenous salts suffered a little. On August 16th and 17th, the field was irrigated for fear that the wind and very little rain might continue.

In connection with this experiment, the growth of plants was determined. For the purpose of this work, 12 portions of 6 plots, described elsewhere, were used. Half of these were planted with one variety, and the rest, with another, the latter differing from the former in stooling habit, texture, and number of grains per panicle. Ten plants were measured in each portion. Five rows of each variety were selected and as each row received six different conditions of treatment, the difference in the rate of growth would be exhibited by the plants from five mother plants. Also the difference in the rate of growth of plants from one mother plant could be determined.

FIELD METHODS

Selection:—In selecting the mother plants, attention was given largely to the plants having the greatest number of grains on the panicle. The number of culms was not considered because the planting was very thick, there being 75 to 175 plants to a square meter. The plants that grew along the outside of the field had many more culms than those that grew in the more thickly planted part within.

Harvesting:—Before harvesting, plants were selected and marked. In harvesting the marked plants were pulled up with the roots. These were then placed on a flat surface and the best plants further separated to be used as mother plants.

The plants were described according to the following points:

1. Height.
2. Length of panicle.
3. Number of bearing culms.
4. Length of longest leaf.
5. Width of longest leaf.
6. Number of grain.
7. Weight of grains.
8. Length of grain.
9. Width of grain.
10. Color of hull.
11. Color of rice.

The field was plowed in April with heavy plow, and then with an ordinary plow on May 28. The harrowing was done twice before application of fertilizers.

The whole field was divided crosswise into two equal parts, the dividing line being marked by a path 3 meters wide

Each of these halves was in turn subdivided into six plots, made by staking off the width into distances of two meters, allowing a path of one meter between each of the lengths staked off. Both the halves are thus divided into plots measuring 2 meters by 50 meters; the furrows ran across and continued through the plots. Each furrow running from one end of the field towards the other end of the half-mark was occupied by seeds obtained from an individual selected mother plant. With this arrangement, each plot contained a certain number of seeds from one common mother.

Application of Fertilizers:—The fertilizers in this experiment were broadcasted, each plot receiving a different fertilizer or fertilizer combination, with one blank plot for a check. The plots were then harrowed lengthwise. The fertilizers applied were as follows:

1. Horse manure applied alone at the rate of 900 p. b. (petroleum boxes) per hectare.

2. Equal parts of horse manure and wood ashes at the rate of 500 p.b. per hectare.

3. Horse manure, wood ash, and double superphosphate at the rate of 300 petroleum boxes, and 100 kilograms respectively.

4. Ammonium sulphate at the rate of 401 kilos per hectare.

5. A combination of ammonium sulphate 401 kilos, potassium chloride 50.4 kilos and double superphosphate 144.7 kilos per hectare.

The three combinations above were recommended by Mr. C. Balangue in his thesis published in The Philippine Agriculturist and Forester, Vol. V, p. 158. (4) Because the horse manure was well rotted, the amount recommended was trebled. In the commercial fertilizer combination, only the amount of the three principal elements was followed(3).

Planting:—At the agricultural station of Bihar(5) a spacing of 18 inches, with 4 seedlings to a hill was found best when the field received 160 tons of manure, one seedling only exceeded the others. In Burma (6) similar experiments were made. Two seedlings a hill, 8 by 9 inches, was found best. Due to the variable results of these experiments in methods of planting of upland rice, a different method was used in the present work. At this college, 30 by 40 centimeters is the spacing used. That is, 50 by 10 centimeters was used with one seedling a hill. This was done so that animals might be used in cultivating. Furthermore, it was the plan to plant the seeds as close as is done in the native method.

The rows ran across six plots which received different treatment, and in each, only seed from one mother plant were planted; so that the effect of each fertilizer would be seen on each individual plant's progeny. Two to five seeds were placed in each hill, and, when more than one sprouted, the weak ones were pulled up till only one seedling was left. Whenever the grains of the mother plant for a row were more than 288, the one-meter space between the plots was filled also, and when only enough seeds were present two hills only on both sides of each plot were planted; and the thinned-out seedlings were planted in the one-meter space later.

Weeding by hand was done twice in the plots of *Inintiw* and *Pinursigue* and three times in the other four varieties; the former two varieties produced an abundance of culms and shaded the weeds well. But for the *mutha* (*Cyperus rotundus* L.) weeding would have been unnecessary. Cultivation alone would have been enough to keep the weeds

down while the rice was small. But because of the *mutha* which could not be killed by shallow cultivation, hand weeding was necessary.

Harvesting:—The panicles harvested in each plot from plants in the same row were kept in separate paper bags. The total panicles and the plants were counted. After air drying, the panicles were threshed and the grains cleaned and weighed. The weight of each plant and the yield per hectare were computed.

RESULTS

Growth:—Table 1 (Appendix) consists of average of growth of ten plants out of each of twelve plots of 2 varieties used. Averages of total growth show that a readily available commercial fertilizer, ammonium sulphate, either single or in combination with other fertilizers promotes greater growth during the early part of plant life than any of the other fertilizers used, although none of the average growths of the fertilized plants were less than that of the control plants. But in the later part of the experiment with the variety *Inintiw* the plants receiving combination of ashes, horse manure and double superphosphate gave the highest rate of growth; the plants receiving ammonium sulphate came second; and those receiving ammonium sulphate combination, third. On the other hand in the variety *Kinanda* the ammonium sulphate in combination still maintains a higher rate than any plant in other plots. In both varieties the total growth of the fertilized plants is always higher than the unfertilized plants.

Even if rainfall was below 2 centimeters per week it did not affect the rate of growth. This may be due to the fact that the field was cultivated whenever necessary, and that the water was conserved. Thus there was constant supply of water in the soil for a large part of the time.

PRODUCTION

Table II (Appendix) is the computed yield of each lot of variety *Kinagaykay*. In this variety the progeny of individuals varies widely in production. The lowest is 1,266 kilos per hectare in the check plot, while the highest production is 5,626 kilos per hectare in the same plot. In response to the effect of the fertilizer, the yield of the plants, even some that came from the same mother, exhibited wide variation. For example, the progeny of mother plant from Serial No. 14, which produced 5,332 kilos per hectare in the check plot, produced only 854 kilos per hectare in Plot II and 1,404 in Plot VI, while, on the other hand, progeny of mother plant from Serial Number 9 produced 5,626 in Plot I, 6,526 kilos in Plot II, 5,088 kilos in Plot III, 6,334 in Plot IV, 2,408 kilos in Plot V and 4,304 kilos in Plot VI. These figures are fairly uniform. Likewise, mother plants from Serial Nos. 1, 4, 6, 7, and 25 may be considered as sufficiently uniform and productive.

The average yield of *Kinagaykay* in the check plot was 64.11 cavans, which compared favorably with the high-producing lowland varieties in yield. This variety responded to commercial fertilizer and combination of ash and horse manure. Plots II and V showed negative results. The three satisfactory fertilizers seem to produce equal results, being 71.11 cavans, and 72.76 cavans and 71.6 cavans.

Table III is the computed yield of each lot of the variety *Guluyang Pula*. In this variety the variation of yield is from 1,242 kilos per hectare to 4,220 kilos per hectare in the check plot. The variation of the yields of plants from the same mother plant ranges from 330 kilos to 3380 kilos per hectare in the case of mother plant from Serial No. 4. In this variety plants from mother plant from Serial Nos. 2 and 18

may be considered as fairly productive, mother plant, from Serial No. 2 produced 4.178 in Plot I, 1,846; in Plot II, 3,036; in Plot III 5,142; in Plot IV, 4,676 in Plot V, and 1,650 kilos in Plot VI.

Mother plant from Serial No. 18 produced 3,916 kilos in the check plot and 4,240 kilos in the Plot II.

Only combination of horse manure and ash proved satisfactory for this variety. The check plot yielded 58.23 cavans, and the yield of the plants in Plot IV was 61.11 cavans. All other plots showed negative results.

Table IV consists of the computed yields of plants from each lot of variety *Kinamaleg*. The variation of the yield in each lot of the check plot is from 780 to 4,658 kilos per hectare, while the variation of lot planted with seeds from the same mother plant is from 492 to 2,408 kilos per hectare. The high producers in this variety are mother plants No. 7, 8, and 2, all giving over 50 cavans in every plot where they were planted.

The average yield of this variety is 56.42 cavans per hectare but this has been raised to 57.58 cavans by fertilizing

Note: *Guluyang Pula*, *Kinagaykay*, *Kinamaleg* and *Kinanda* produced very few culms so that it is possible to increase the yield by increasing the number of plants per hill.

Table IV (Appendix) consists of the computed yields of each lot of the variety *Kinanda*. In the check plot the production varies from 884 kilos to 3,504 kilos per hectare and the variation of yields of plants from the same mother varies from 884 to 3,702 kilos per hectare. The mother plants that exhibited uniformity in this variety are serial Nos. 49, 23, and 18. The production of these in any lot was not less than 45 cavans per hectare.

The average production of this variety in the check plot is 52.01 cavans; this can be raised to 80.3 cavans by the addition of ammonium sulphate. The combination of wood ashes, manure, and double superphosphate raised this to 71.9. Only Plot II showed a negative result, all others raising this yield to over 61 cavans. The low production is 1,200 kilos and the highest is 6,348 kilos per hectare.

Table VI consists of the computed yields of each lot of the variety *Inintiw*. In this variety the production varies from 1,298 kilos to 3,876 in the check plot and the variation in the production of plants in lots of the same mother plant is from 1,854 to 5,672 kilos per hectare. The mother plants that may be considered productive are serial Nos. 60, 3, 23, 46. None of these produce less than 50 cavans in any lot. In all the lots the lowest yield is 1,298 kilos and the highest, 5,748 kilos per hectare.

The average production of this variety in the check plot was 58.79 cavans. This was raised to 101.06 cavans per hectare by the application of the combination of ammonium sulphate, potassium chloride and double superphosphate. Ammonium sulphate alone raised this to 77.02 cavans per hectare.

Table VII consists of the computed yield of each lot of variety *Pinursigue*. In the check plot the production of this variety varies from 1,498 kilos to 6,444 kilos per hectare. The variation in the rate of production of the progeny from the same mother plant is from 1,866 kilos to 6,000 kilos per hectare. The lowest yield is 1,348 kilos and the highest, 6,884 kilos per hectare. 1,248 kilos is the production of mother plant No. 10 in Plot I, and 6,884 kilos is the product of mother plant No. 11 in Plot VI.

The average of this variety in the check plot was 69.34 cavans and this was raised by the application of manure

and ash to 96.08 cavans per hectare. The plots that received ammonium sulphate, potassium chloride and double superphosphate rank third with a difference of 2.1 cavans. The difference between the check yield and the yield of Plot IV was 27.26 cavans per hectare.

CONCLUSIONS

1. Ammonium sulphate, alone, hastens the growth of young rice plants; and a combination of ammonium sulphate, potassium chloride and double superphosphate, or a combination of horse manure, ash, and double superphosphate promotes the growth of rice plants at a later stage of development.

2. With selection in mass it is possible to raise the yield from 59 to 69 cavans in certain varieties, without any fertilizer.

3. With the application of ammonium sulphate, potassium chloride and double superphosphate, it is possible to raise this yield to 101 cavans in certain varieties.

4. Different varieties, even though planted with the same spacing, vary greatly in yield.

5. Mother plants of the same variety may produce progeny widely different in yields.

6. With single good initial selections alone, in certain cases, it is possible to produce at the rate of 149.8 cavans (6,444 kilos) per hectare, as shown by mother plant serial No. 22 of the variety *Pinursigue*.

7. With the application of proper fertilizer it is possible to raise this rate to 160 cavans (6,884 kilos) per hectare.

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APPENDIX

TABLE I

AVERAGE RATES OF GROWTH

Variety Inintiw, College No. 6036

Date	Plot I	Plot II	Plot III	Plot IV	Plot V	Plot VI
July 1	7.07	9.48	8.05	7.99	10.58	9.64
July 8	9.81	4.36	14.25	11.67	7.78	8.93
July 15	4.45	8.05	7.37	5.90	8.42	9.99
July 22	7.01	8.22	14.38	11.48	10.19	13.42
July 29	4.39	6.79	9.48	4.70	5.41	5.43
Average 5 weeks	6.54	7.38	10.70	8.34	8.47	9.48
Aug. 5	6.16	9.19	12.02	7.68	12.49	13.91
Aug. 12	4.16	8.30	8.58	6.95	6.13	7.24
Aug. 19						
Aug. 26	8.21	5.62	8.35	11.36	12.12	12.01
Sept. 2	8.27	2.90	3.55	4.28	9.17	6.75
Sept. 9	4.45	4.57	15.50	4.95	18.48	13.00
Sept. 16	16.80	16.68	12.70	20.20	9.10	15.35
Sept. 23	20.55	20.70	20.80	17.10	16.70	15.05
Average 5 weeks	11.65	10.09	12.02	11.58	13.03	12.43
Sept. 30	1.1	2.10	5.30	3.85	3.20	2.77
TOTAL	102.43	106.96	140.33	118.14	129.77	133.42
AVERAGE	7.31	7.64	10.02	8.43	9.27	9.53

Variety Kinanda, College No. 6037

Date	Plot I	Plot II	Plot III	Plot IV	Plot V	Plot VI
July 1	7.14	6.86	16.61	9.35	9.00	12.43
July 8	9.61	11.63	14.46	10.15	8.49	11.44
July 15	10.02	6.23	18.19	16.51	14.51	16.83
July 22	5.49	11.96	7.74	12.07	9.18	10.75
July 29	8.62	12.42	7.83	9.02	19.91	9.77
Average 5 weeks	8.17	9.82	12.96	11.42	11.42	12.24
Aug. 5	10.54	9.33	4.16	7.40	8.73	3.13
Aug. 12	6.38	10.40	5.37	6.18	5.11	4.85
Aug. 19						
Aug. 26	6.03	7.35	6.00	4.85	6.53	3.20
Sept. 2	15.25	12.05	8.10	13.30	7.75	1.65
Sept. 9	15.20	10.80	8.95	11.05	13.80	20.70
Sept. 16	1.80	3.70	7.80	5.05	6.10	11.20
Sept. 23	.40	3.40	3.60	3.70	.90	2.86
Average 5 weeks	7.73	7.46	6.89	7.59	7.01	7.92
Sept. 30	.00	.10	1.70	1.00	.00	.00
TOTAL	96.48	106.23	110.50	109.63	110.01	110.81
AVERAGE	6.89	7.58	7.89	7.83	7.85	7.91

TABLE II

COMPUTED YIELD OF EACH LOT IN KILOS PER HECTARE

Variety Kinagaykay, College No. 6040

Serial No. of Mother Plants	*Control*	*Horse Manure*	*Ammonium Sulphate*	*Horse Manure & Ash*	*Horse Manure Ash & Double Sulphate*	*$(NH_4)_2SO_4KCl$ Double Superphosphate*
1	2068	2040	3600	2490	3666	4302
2	2612	1634	1528	3466	4330	4304
4	4412	2532	5676	6266	2866	3116
3	4834	3850	2110	3250	1904	1550
6	2388	3094	3390	2884	1526	2176
7	2354	2806	2964	2518	1532	3682
8		1510	2320	2952	2856	3050
9	5626	6526	5088	6354	2408	4304
14	5332	854	4104	3280	1886	1440
12	2244	944	3790	2776	5020	3592
13	1596	2000	3320	2650	1126	4000
21	1682	2284	2350	2258	1822	2166
25	2118	1842	2804	2326	2034	3708
27	1936	1276	2820	1844	3042	3092
17	1266	2240	2412	2836	1636	2846
18	1570	2006	1622	2826	2532	2400
19	2866	3876	1783	3272	2883	2900
20	1788	2864	3370	2074	2420	2830
TOTAL						
Average in Kilos . .	46870	44178	55050	56322	45488	55438
Average in Cavans	6411					

TABLE III

COMPUTED YIELD OF EACH LOT IN KILOS PER HECTARE

Variety Guluyang Pula, College No. 6041

Serial No. of Mother Plants	*Control*	*Horse Manure*	*Ammonium Sulphate*	*Horse Manure & Ash*	*Horse Manure & Double Superphosphate*	*$(NH_4)_2SO_4$ + KCl Double Superphosphate*
1	4220	2216	1176	3130	2232	2140
2	4178	1846	3036	5142	4676	1650
3	2430			2448		
4	3380	3468	530	950	2174	1992
5	1242	3786	1760	3500	2186	3380
6	3082	908	3292	2272	1362	2000
7	1750	2700	1402	1428		2258
8	2420	1656	605	1926	1248	1958
9	2034	1524		1108	1774	3760
10	1066	3312	1466	1486	1186	4234
11	2066	2514	1456	2016	1914	4120
12	1416	2520	2266	1042	1418	3480
13	2284	2044	1976	2964	1670	2760
14	1778	1882	1460	1978		3000
15	2282	4418	2878	1478	1106	2860
16			2910	1734	1600	1460
17	2568	2308	2634	2634	756	1660
18	3916	4240	3062	2378	2000	2762
19	1724	1794	1986		1222	3392
20	2932	3108	3328	1316	710	842
21	3240	2242	2410	1202	1070	840
22	1550	2046	2550	1362	520	700
23	——	——	——	——	——	——
24	——	——	——	——	——	——
25	3368	2900	3686	1188	——	——
26	2674	1182	2672	2000		1200
TOTAL.....	57600	54614	53586	46682	30824	52448
Average in Kilos..	2504	2482	2436	2629	1622	2384
Average in Cavans	50.23	57.72	56.65	61.11	37.72	55.44

TABLE IV

COMPUTED YIELD OF EACH LOT IN KILOS PER HECTARE

Variety Kinamaleg, College No. 6039

Serial No. of Mother Plants	*Control*	*Horse Manure*	*Ammonium Sulphate*	*Horse Manure & Ash*	*Horse Manure Ash & Double Superphosphate*	*$(NH_4)_2 SO_4$ + KCl Double Superphosphate*
16a	3850	3138	2920	2920	3758	3400
16b	2358	1322	1036	1556	3164	3174
1	4658	2544	1364	956	2690	1298
2	2314	2388	2306	1780	1916	2762
3	2306	2742	2340	2466	2240	3974
4	1982	1798	2934	1288	2526	2532
5	1854	2160	1648	2358	2120	3140
6	1348	1358	3162	1224	1318	2512
7	3886	2352	2708	2980	2616	2650
8	3442	2212	1890	2834	2330	
9	2542	1848	1060	2506	1500	
11	2064	1100	1832	1714	1588	1964
12	2750	2362	1630	1566	2316	3756
13	780	1590	1706	1160	2082	3150
14	2866	1536	1554	1386	1816	2332
15	2337	1630	——	1084	1864	1748
16c	3142	2648	1146	1952	2490	1554
17	1602	1322	2198	1528	1568	1984
18	1962	1132		990	2630	1818
19	1332	948	492	766	680	1724
20	1066	804	2338	496		2408
21	2750	2684	2080	1138	1992	2932
22	2452	1858	1702	1400	1798	1960
23	2462	1634	——	1706	2218	2890
TOTAL.....	58228	43390	38926	33982	48332	54474
Average in Kilos.	2426.1	1807.6	1853.6	1415.08	2101	2476.08
Average in Cavans	56.42	42.04	43.1	32.908	48.86	57.58

TABLE V

COMPUTED YIELD OF EACH LOT IN KILOS PER HECTARE

Variety Kinanda, College No. 6037

Serial No. of Mother Plants	*Control*	*Horse Manure*	*Ammonium Sulphate*	*Horse Manure & Ash*	*Horse Manure Ash & Double Superphosphate*	*$(NH_4)_2SO_4$+ KCl, Double Super-phosphate*
8	884	1654	2244	2530	2056	3702
12	1872	1200	3420	——	1950	3494
13	2818	1318	2354	2178	2162	2178
16	3248	4360	2922	2550	3362	——
17	2300	2520	5110	1836	6348	3764
18	1918	——	3640	2352	3714	——
20	3798	1422	3438	2384	1604	5054
21	2018	1446	4196	1896	2352	3072
22	1902	1798	2836	2658	2358	2506
23	2052	1700	3454	2070	2324	3526
24	——	1920	2270	3112	2980	1698
25	2850	2650	2500	964	3294	——
26	1728	1842	3924	2576	3018	2004
27	2290	1952	2064	1970	3170	2000

TABLE V—*Cont.*

COMPUTED YIELD OF EACH LOT IN KILOS PER HECTARE

Variety Kinanda, College No. 6037

Serial No. of Mother Plants	*Control*	*Horse Manure*	*Ammonium Sulphate*	*Horse Manure & Ash*	*Horse Manure Ash & Double Superphosphate*	*$(NH_4)_2SO_4$+ KCl, Double Superphosphate*
28	1898	1750	2790	2540	2670	2254
30	1596	2580	——	——	1462	2764
33	1708	572	——	3752	2876	1906
37	1222	2680	3540	1746	1768	3000
38	2000	2132	4020	3090	3376	2016
44	2296	1856	1722	2000	1858	3094
46	1200	2190	2078	2016	2668	2376
40	2748	——	1598	2016	2710	1690
48	——	2026	1976	4462	2124	2082
49	3504	3060	2880	4636	2302	3154
50	2080	2144	1342	2598	3224	1846
51	2468	2100	1598	1492	3866	2116
53	1800	1020	1622	1114	2400	2634
55	2286	——	1586	2206	2054	3792
56	1876	1100	2500	2442	3832	1580
TOTAL.....	58490	50992	93734	71176	89682	69202
Average in Kilos..	2240	1961	3842	2636	3093	2662
Average in Cavans	52.01	45.6	89.3	61.3	71.9	61.9

TABLE VI

COMPUTED YIELD OF EACH LOT IN KILOS PER HECTARE

Variety Inintiw, College No. 6036

Serial No. of Mother Plants	*Control*	*Horse Manure*	*Ammonium Sulphate*	*Horse Manure & Ash*	*Horse Manure Ash & Double Superphosphate*	*$(NH_4)_2SO_4$+ KCl, Double Superphosphate*
2	3110	1648	5166	3774	3188	3092
3	3644	2810	2890	3608	3284	4060
4	1298	3336	4790	2460	3714	3518
7	3288	2170	3800	3212	4522	3446
60	2544	——	3350	2594	——	5326
19	2812	4090	4090	4118	3762	3902
21	3170	2154	3792	——	3464	5748
22	2316	2036	3586	3670	2402	5150
23	2852	2024	2336	3158	4686	5672
24	2664	2762	1854	3492	——	——
25	1920	1860	——	3426	2902	3950
27	2250	1814	1790	3334	2642	3848
28	1928	2300	2350	2462	2724	4246
29	2404	2428	2656	3528	3286	5080
30	2372	2400	2222	2142	2826	3354
31	3696	5400	5146	3394	3432	2740
32	1954	2186	4400	2882	2236	4120
33	1600	3420	3992	2346	2798	3218
35	2084	2604	3392	5760	3310	4418
37	1626	2420	——	3424	3520	——
45	3876	——	2598	2636	3866	4956
46	2924	——	3000	2522	3236	5466
52	2528	2464	3622	1622	2724	4474
54	1900	2556	——	2388	——	5920
59	3430	2220	2442	3284	3736	4660
10	3362	——	3094	2452	2764	44 4
12	2432	2082	2920	3050	2212	3690
65	1574	2616	3422	5064	3086	4520
TOTAL.....	70776	60522	82800	86900	70454	113008
Average in Kilos..	2528	2247	3312	3218	2818	4346
Average in Cavans	58.79	52.25	77.02	74.83	65.53	101.06

TABLE VII

COMPUTED YIELD OF EACH LOT IN KILOS PER HECTARE

Variety Pinursigue, College No. 6038.

Serial No. of Mother Plants	*Control*	*Horse Manure*	*Ammonium Sulphate*	*Horse Manure & Ash*	*Horse Manure Ash & Double Superphosphate*	*$(NH_4)_2 SO_4$+ KCl, Double Super-phosphate*
1	2338	1894	——	——	3248	2098
2	3088	3208	3208	3724	5580	3240
3	2894	2010	4236	4006	4688	3836
4	3736	——	2496	——	——	2562
6	2442	2395	3456	4690	2020	4870
7	2310	1760	2456	3492	2452	3370
8	1866	2298	2326	6000	3362	3700
9	2564	3146	4262	4810	4202	4812
10	1248	2748	2688	3820	4682	2674
12	1494	3192	6478	6228	5244	2550
13	1930	3196	3862	4230	6332	1554
15	1948	2004	3572	3180	3722	3660
16	1950	3200	4100	4290	4376	1836
17	2142	2100	2554	——	2908	5276
18	2800	3632	4400	4666	4016	2846
19	2666	2684	2202	3876	4584	2666
21	2584	3992	3858	——	——	5120
22	4016	3216	2862	——	3492	3180
24	2132	2388	——	3980	3956	3444
26	1948	1846	2926	3430	1150	3686
27	2480	2750	3872	2346	3826	2950
29	4354	1606	3784	6016	3808	2450
30	3834	3020	——	——	3330	5554
31	6444	3352	3324	——	——	——
32	5674	——	5518	——	3858	——
37	6050	3008	5218	2406	3108	——
39	2624	2204	4256	3340	3400	4210
11	2322	2672	3416	4686	4682	6884
5	3900	3820	4166	3545	2554	4306
TOTAL.....	86472	73571	95606	87261	98680	93334
Average in Kilos..	2982	2726	3677	4155	3411	3589
Average in Cavans	69.34	63.30	85.50	96.60	79.30	83.40

A Study of Onion-Growing at the College of Agriculture

By Dionisio Pastorfide

Thesis presented for graduation from the College of Agriculture No. 69.

The fact that the Philippines import every year thousands of bushels of onions from different parts of the world shows that a large amount of money is going out of the country for this purpose, and this will surely increase from year to year unless our farmers give attention to the raising of this crop. Onions are eaten very commonly,in *pansiterias* especially, in hotels and restaurants, and as a common part of the food of the people, and are a necessity in many culinary preparations. They are also eaten raw, both leaves and bulbs, here as elsewhere. Pickled onions keep indefinitely and furnish a good appetizer. Because of the natural increase of the people of the Islands, and because of the fact that the people are accustomed to eat onions, there is good reason to believe that the raising of this crop will eventually be one of the important occupations of the people. It is then necessary that trials be made in all parts of the Islands in order to determine in what parts the growing of onions will be possible and profitable, so that the introduction of this crop into the Islands may be encouraged.

Onions which the Philippines use come from Japan, China, India, the British and Dutch East Indies, Australia, Spain, the United States, Siam and Singapore. The largest amount comes from Japan, China and Australia, as shown in the following table:—

Extract from the Annual Report of the Insular Collector of Customs for the fiscal year 1907 up to the fiscal year ending June 30, 1913.

FISCAL YEAR ENDING JUNE 30, 1908.

Source	*Value $ 1907*	*Quantity bushel*	*Value 1908*	*Calculated cost per bushel in $*
Spain	.....	229	405	1.77
China	.....	12,689	10,967	0.864
Japan	.....	80,752	56,948	0.7052
British East Indies	.....	14,116	18,552	1.3142
British and Dutch East Indies	.....	69	68	0.985
British Australasia	.....	11,655	9,077	0.778
Siam	.....	40	40	1.00
Total	105,712	119,550	96,057	0.8035 ave.

	Quantity kilos 1908	*Value $*	*Quantity kilos 1909*	*Value $*	*Calculated cost per kg. in $*
Spain	5,912	400	.....	.....	.....
China	328,074	10,967	284,478	14,277	0.0502
Carried forward	333,995	11,367	284,478	14,277	0.0502

TABLE I

Source	*Kilograms*	*Value $*	*Calculated cost per kilo in $*
United States	7,206	265	0.03677
China	521,237	15,082	0.02893
Japan	2,817,939	68,602	0.02431
British East Indies	86,662	5,331	0.06151
Dutch East Indies	10,375	670	0.06457
Australasia	1,231,110	42,229	0.0343
Egypt	4,442	68	0.01530
Total	4,678,971	132,247	0.03795 ave.

The average import of the Islands is about 3472 tons costing ₱277, 750.80, about 8 centavos per kilo. With the expenses for hauling, the price is naturally raised. Other reasons for the raising of prices are the duties and the disposition of the importer and retailer to make a maximum profit.

In the little stores near the College of Agriculture, the price of onions per kilo is 27 or 28 centavos; at Bay, a town near the College of Agriculture, 20 to 28 centavos; at Los Baños 20 to 25 centavos, and in very distant provinces, to which transportation is very difficult, the price is probably very much higher than the highest above mentioned.

Imported onion seeds were formerly grown in the college nursery and thence transplanted to one of the trial beds in the college garden. They grew very well, the leaves were big and strong but they did not make bulbs. However, small ones were developed which when pulled could be marketed as green onions. It is probable that onions can not be grown in all parts of the Islands for many reasons, the chief of which are the lack of the proper soil conditions, and a climate that is either too hot, too cold or too wet.

In Taal, Batangas, onions are cultivated quite extensively but the use of this crop is mostly local, little being sent to Manila or towns in the neighboring provinces. They are usually sold as green onions. These are the "native" onions which multiply rapidly, producing in one generation four to ten small bulbs. The varieties used are the white and the purple, both of which are common all over the Islands.

Joseph A. Cocannouer (1) succeeded in growing onions at the Indang Farm School, Cavite. He used the Bermuda, Creole, and Silverskin varieties. The first is a quick grower, although it does not attain the size of the standard varieties. It is resistant to heat and possesses a mild flavor. The Silverskin variety yields fairly well.

It is recomended that if Bermuda seed cannot be obtained, the Creole be substituted. Seeds that come from the colder regions of the United States, Europe or Australia, do not grow as well as those that come from the warm regions around the Gulf of Mexico, or the Mediterranean.

In Central Luzon, seeds are sown in the middle of August (1) and if there is irrigation they may be planted at other times. Onions must have a soil consisting of about half sand and half loam. The plants must receive a cultivation similar to that given the ordinary garden crops. The seeds are sown in boxes (1) and then set out in the field, when strong, or sown directly in the field. Sunshine has to be regulated until the young seedlings can resist the direct heat of the sun. The seed boxes are covered with thick straw for about one week until the seeds have germinated. Then they are protected from too much heat until they are ready for exposure to direct sunlight.

Onions are successfully grown in many other warm countries under conditions that can probably be duplicated in the Philippines Islands. G. M. Woodrow (2), says, "Few vegetables are cultivated with more success in the dry parts of India than this wholesome esculent." The variety used resembles the pale-red onions of Europe; on the average it weighs ½ pound, and is 2½ inches in diameter. For green onions, seeds are sown twice a month. In rainy weather a thorough drainage is provided, and in dry weather, slight shade to protect the plants from the hot winds and the plants are watered once daily.

Cameron (3) says that the cultivation of this crop is successful in the upper province of Calcutta. "Varieties imported from Australia and the United States are better adapted to the warmer part of India, than are the English and Spanish varieties."

G. P. Foaden and F. Fletcher (2) suppose that this plant occupied a vast area in Western Asia perhaps from Palestine to India, whence it passed into Egypt, where it was cultivated a long time before the Christian era.

It is grown very commonly along the fertile banks of the Nile and on small alluvial islands in Upper Egypt. The cultivation of this crop has undergone a great development during the past few years. The following figures show the average exports from 1884 to 1905:

From	1884-88	11,320	tons	valued at	£	33,402
"	1889-93	32,779	"	"	"	997,158
"	1894-98	54,166	"	"	"	153,876
"	1899-03	68,238	"	"	"	160,797
In	1905	112,384	"	"	"	393,349

The average price is thus about £3 (₱30.00) per ton.

Egypt became the center of transportation to England and to Austria with competition from Italy and Asia Minor.

In some countries of the world, certain localities with especially favorable conditions have developed into great onion-producing centers. "A group of Islands in the Atlantic Ocean, the Bermudas (5), belonging to Great Britain lying in 32°15′ N and 64° 50′W about 580 m. E by S. from Cape Hatteras on the American coast", has soil and climatic conditions most favorable to the growth of onions. The soil, a curious red earth, is covered with vegetation of perpetual green, and is mostly calcareous.

The climate is mild and fresh. "The maximum reading of thermometer is 87°F, and its minimum, 49°, the mean annual temperature being 70°". Great amounts of onions are shipped to New York from this source.

The following statement is found in a recent issue of *The California Cultivator* (6): "The Onion Growers' Association of Antigua, British West Indies, is handling, packing, shipping and selling coöperatively a great proportion of the onion crop of the islands and has gotten for the produce of Antigua a degree of recognition for uniformity and excellence in quality, which is proving of very great service to industry".

"Antigua lies in 17° 45′ W. and 50 miles east of Saint Kitts, and is 45 miles in circumference with an area of 108 square miles." The surface is flat with a mountain having a height of 1,328 feet. The people are dependent upon the rainfall, which has an average of 45.6 inches. There is no river, so the island is subject to drought. The air is dry. There is a great variation of climate every year. The soil is fertile, especially in the interior". (7)

H. F. Macmillan (8) says that onion yields fairly well in up-country gardens in Ceylon, and far better results are obtained at intermediate elevations. A dry, rather than wet, climate is best for their growth. The soil is of various kinds in different localities. (9) In general the soil is made up of quartzose, gravelly, feldspathic clay and sand "often of a pure white, blended with or overlaid by brown or red loam resulting from the decayed vegetable matter, or the disintegration of the gneiss and hornblende formation." All of the northern extremities are admixtures of sand and calcareous rocks. The general character of the soil in the provinces along the border to east, west and south is sandy.

In order to raise onions successfully and profitably in the Philippines it is

then necessary to make thorough tests everywhere, throughout the Islands, together with careful studies of the special local conditions under which the growing is attempted. Only in this way will it be possible to discover the regions most perfectly adapted to onion culture.

SOIL AND ITS PREPARATION

A good soil for this plant is rich, with plenty of decomposed vegetable and animal matter, and about half sand. (1) It must be free from weeds, and well pulverized, so that the delicate roots of the plants can easily penetrate it and find the essential nourishment to maintain their growth. In Egypt (4) the following directions for planting onions were recommended: "On ordinary cultivated land, under the canal system of irrigation, two to three ploughings are usualy given, after which the land is harrowed and then ridged. The ridges are made to run from East to West, the distance between their crests being from 60 to 65 centimeters. Water is allowed to flow into the furrows between the ridges until these are about two-thirds filled. The seedlings are then pushed by the finger into the mud just on the line marked by the water on the sides of the ridges. Both sides are planted with seedlings, at a distance of about 15 centimeters apart.

On the river bank nothing is done to the soil. The seedlings are planted on the flat, either singly in rows, the rows being 35 centimeters apart, or in small groups, these being in rows 50 centimeters apart. The seedlings are planted in the mud, and the crops are raised without any irrigation, the necessary water being supplied by the alluvium. In some few cases the plants are earthed up, the soil being accumulated around the bulbs.

The seeds are sown either directly in the bed or in boxes. Planting seeds in the furrows ought to be at a rate that will insure a good stand. They are then covered lightly with fine soil about 0.5 centimeter thick. It is very necessary that the seeds be of good quality, and fresh.

Onion seeds do not keep long, usually not over a year. It is very important to note that seeds from very cold places, such as the northern United States and probably the northern countries of Europe, do not grow as well as those from the subtropical countries. The above fact was found in actual experiments at the Indang Farm School, Cavite (1), and elsewhere.

Planting is done as soon as the land is ready. Where the cultivation is mostly accomplished by hand, the distance between the rows may be from 10 to 24 inches. Where the cultivation is more extensive, carabao or vacas may be employed. In this case a greater distance is required, usually from 24 to 36 inches. (10)

The quantity of seeds needed to plant a hectare of land depends on the distances between the rows and the purposes for which they are raised. For large, hard market onions, a rate of from 9 to 10 pounds of good seeds is required. (10) Allowing one ounce (Germain Seed Co.) to every 100 feet of drill, it will require about 13.2 pounds to the hectare, which, at the rate of 2 centavos to every 10 grams of seeds, amounts to ₱120.

For the smaller pickling onions a greater quantity is required, about 50 pounds to the hectare. (10) In order to insure a good stand, it is necessary that a small quantity of seeds be placed in a moist blotting paper or cloth, and the germination percentage thus determined, after which a safer estimate can be made for planting requirements.

The cost of the seed varies, depending on the quality, vitality and competition in its sale. Good seeds sell usually from ₱3 to ₱5 a pound.

The growing of green onions is a phase of onion culture that is of considerable importance in certain localities, especially near large towns and cities. The demand for this product is always greater than the supply. People who are engaged in other lines of work can afford to plant a piece of land with this crop as a side issue. It does not require long study and experience. It is a crop that does not require as much attention as some others. At the College of Agriculture it takes only from 45 to 60 days to get it ready to market. The onions that may be employed for this purpose are the native, partially spoiled or sprouted market onions, and onion sets.

The cultivation of this crop should be begun as soon as it is possible to stir the soil and to free the plant from weeds. (4) Cultivation is very essential, since without it the plants will not make bulbs. Care must be taken not to injure the roots of the plant, and to do this, shallow cultivation may be given to advantage. In Egypt (4) the cultivation of this plant with fass has been replaced by the hand hoe. "As a rule cultivation is given on the thirtieth day after planting and followed by a second cultivation twenty-five days later," although, wherever possible, frequent stirring up and weeding are recommended.

Water is one of the most essential factors in the growth of the onion. Watering should be adequate, but not so excessive as to soak the soil. Frequent watering is injurious (4), besides inducing the plant to form big heavy tops which prevent normal maturity and resulting in the development to small spongy texture. No watering should be allowed near the harvesting time. Water at harvest time, or just before, causes a secondary growth which affects the quality and flavor of the bulb. In very dry weather, usually from February to March in most parts of the Philippines, the interrows should be deeply furrowed and the water run through, and then covered with soil to prevent evaporation.

The time of ripening is easily determined. The leaves of the plant become yellow, although there may still be occasional green ones. The fullness and hardness of the bulbs are other indications of ripeness. The easiest and best method of harvesting is to pull the plants. A man can pull them very rapidly in two rows while he proceeds from one end of the plot to the other between the rows. The time to harvest onions depends entirely on the variety and purposes for which they are raised. For early green onions the plants may be gathered in from one to one and a half months. By this time the bulbs are small and crisp, and the leaves are long, slender and succulent, and thus best suited for culinary purposes.

CLIMATE AND RAINFALL

The onion is remarkable in that it will thrive under very varying climatic conditions. The raising of onions is hardly profitable in places where the climate has no distinct seasons, wet and dry or hot and cold (10). The onion requires plenty of moisture during its early stages and a reasonable amount of heat towards the time of maturity. If onion bulbs ripen when there is much rainfall, they may be cured and kept only with great difficulty.

It has been found here and in Taal, Batangas, that the multiplier of the native onions may remain in the ground over maturity, especially after a heavy

rainfall, without the already formed bulbs degenerating. However, they multiply very rapidly, producing many new tender leaves, which when pulled can be marketed as green onions.

The amount of rainfall (10) required by these plants, depends entirely upon the conditions of the soil in which they are grown. Porous, sandy soil requires a considerable amount of rainfall. Peaty or mucky soil, in which the water remains near the surface, requires a far less amount of rainfall. Too much rainfall will cause the onions to form big heavy leaves at the expense of the bulbs.

The climate at the college may be divided into distinct wet and dry seasons. The wet season begins in June and ends approximately in October. The dry season begins in November and ends in May, the hottest period coming about March and April.

The following table shows the rainfall and climate in the College of Agriculture, as given by Dr. Gates. (*)

* Dr. Gates was formerly instructor in botany at this college.

TABLE II

RAINFALL AT THE COLLEGE OF AGRICULTURE

Year	*Month*	*Rainfall inches*	*No. of Days*	*Season*
1913	June	2.31	8	Wet
1913	July	16.62	27	"
1913	August	8.72	28	"
1913	September	11.79	18	"
1913	October	6.85	12	"
1913	November	3.70	16	"
1913	December	3.87	20	Dry
1914	January	0.61	8	"
1914	February	0.36	4	"
1914	March	0.17	5	"
1914	April	2.77	7	"
1914	May	3.08	10	"
1914	June	12.11	19	"
1914	July	5.97	22	Wet
1914	August	8.36	20	"
1914	September	26.65	20	"
1914	October	2.33	16	"
1914	November	3.02	14	Dry
1914	December	2.18	16	"

ONIONS IN TAAL AND LEMERY

The following data were carefully taken by the writer and were afterwards verified by Mr. Pablo Villavicencio, the owner of the largest field of onions there.

The seed stocks used by all planters in Lemery and Taal are bought from the Chinese stores in Manila. These seeds are said to be imported from China. It is said also that onions grown at Lemery and Taal can not be used for seed purposes for the next generation, because they rot before the planting season comes, or, if some keep well, they do not usually produce as good onions as the imported seeds. Therefore the people do not care to store onions sets for seeds, but prefer to buy the imported stock.

The cost of the imported onion seed stock runs from about ₱15 to ₱20 per picul (63.5 kilos), or sometimes even higher. According to their method of planting, a hectare of land would require about 7 piculs of seeds which would cost at this time (November, 1915) about ₱140. The cost for preparing the land

and planting the seeds would run to as high as ₱20 a hectare. The cost of weeding and hand cultivation, which is commonly done twice by the owners themselves and their children, would amount to about ₱15. This estimate is based on the assumption that the family work at the average rate of ₱0.50 a day, for three days. Adding all expenses, the whole cost per hectare would be about ₱175. If we include the rent of the land, which may be estimated at ₱10 per hectare, and the interest on the money invested, 2.66 percent for four months based on 8 per cent per year, the total cost of an onion crop per hectare would amount to ₱189.93.

According to Mr. Villavicencio's long experience, a picul of onion seed yields on an average 7 piculs of marketable onions. Since 7 piculs of seeds are required per hectare, the yield per hectare would be 49 piculs of onions, and sometimes more. The yield of one hectare of onions would then amount to ₱420. The products are usually bought in the field. Deducting the cost from the selling price, it would leave a gain of ₱230.07 per hectare. Deducting the expenses for harvesting and for putting the onions in sacks, and the cost of the sacks themselves, about ₱10 and ₱2.10 respectively, or ₱12.10 to the hectare, there would still remain a net income of ₱217.17.

The land having been prepared, the seeds are then placed in the furrows and lightly covered with soil. The distance from plant to plant is from 5 to 6 inches, and the distance between the furrows from 7 to 8 inches. This space between the furrows will not allow a horse or vaca cultivator or a "Junior" cultivator to pass, so that cultivation is entirely done by hoeing, the ground being worked over once or twice. No irrigation is practiced.

As soon as the leaves turn yellow, which in that region comes at about 3 or 3½ months from planting, banana trunks or empty barrels are rolled over the plants, and a week later the plants are pulled up. The crop is harvested when the weather is favorable to the curing of the onions. These are cured in the field for three days, and then sold to the dealers, who are always on hand.

The land is plowed lengthwise and crosswise and then furrowed by the native plow. Plowing is not deep. The harrow is not used.

The soil in the onion-growing district is generally sandy. This is especially true in Lemery. However, in some places outside the town of Lemery the soil is inclined to be clayey. Even there the onions grow as well as in the sandy-loam soil, and produce equal or greater yield. In Taal, near Lemery, the soil is a dark-brown loam, mixed with sand, especially along the level plain near the river.

Planting is usually done in October or November. By this time the rainy season is about to close. So the onions are given a good season to start with and a good season in which to ripen.

Planters do not purposely pull up the plants to sell as green onions, unless the consumers, dealers or retailers come to the plantation to buy them on the ground. The planters seem to have no interest in this work as trucking but only as cropping on a general farming basis.

Among the pests that appear sometimes in abundance is the "ulalo", a grub found in the ground. This insect is as big as a man's thumb. It eats the bulbs. Crickets commonly eat the leaves. Another enemy of which the planters are complaining, is the "pasic," a fungus disease. Diseased leaves turn yellow and the plants die.

LOCAL WORK

The object of the present study, carried out on the college farm, was to find out whether it will pay to grow onions from seeds or from sets; whether it is economical to plant the sprouting and partially decayed market onions, or whether it is profitable to plant the big, hard market onions for the purpose of raising early green onions; and whether it is advisable to let the native onions remain in the ground beyond the earliest marketable condition; also to determine the proper seasons for planting.

The first lot of seeds and stocks used were bought in Manila in the groceries, the Luzon Floral Co., and in public markets. The second lot of sets and different varieties of seeds came from Germain Seed Co., Los Angeles, California. This experiment was begun on the thirtieth of July, 1914. Different varieties were planted in rows in plots, with the same distance and treatment.

The first planting of onions was begun on the thirtieth of July, 1914. The seed stocks that were employed were the native, the imported big and inferior hard market bulbs of different shape and colors, and partially decayed imported market bulbs. These hard market bulbs were classified according to their appearance, size and color. As a result of the classification thus made, the following were separated. The large flat bulbs both thick and thin; the inferior hard market bulbs of different shapes, and the small uniform oval-shaped bulbs. Their colors and origins are given in the summary table. The partially decayed big-bulb onions were first washed, removing all the decayed parts. If this is not done, the unpleasant odor is retained until the harvesting time.

All the seed bulbs belonging to each variety were counted and recorded. Every seed bulb was weighed, and its diameter measured by means of calipers. The maximum weight and diameter of the seed bulbs, as well as the minimum, was noted, as seen in the summary table. These onions were harvested after two months and ten days in the ground.

The second planting of onions was begun November 18, 1914, and the products were harvested February 13, 1915. In this planting, the materials used were the native, and the imported onion sets and seeds. The same procedure was followed with the seed stocks as in the previous planting.

The third planting was made December 18, 1914. The remainder of the same varieties used in the second planting was used at this time. The plants were harvested March 10, 1915.

The above three groups of experiments were carried on in the college trial plots, each plot having an area of $^1/_{200}$ of a hectare. The plots used for the first test had been previously used for various garden crops, the last being tobacco. The plots occupied by the second planting were formerly also given to garden crops, the last being yautias. The plots used for the third planting had been previously planted to various garden crops, the last being cannas.

The soil was deeply and well prepared by means of the spading fork, and was well pulverized. It took generally from two to three hours' work by two men to prepare one plot.

All the seed bulbs and the seed sets were planted in furrows 24 inches apart, and 10 inches apart in the furrow. The big bulbs were planted so that they were about $^3/_4$ to 1 inch below the surface. The sets were also at about the same distance from the surface of the soil. Then they were covered with fine soil which was pressed down firmly.

The first seeds, the Silverskin, were planted August 5th. They were first sown in a box containing rich and well prepared fine soil, and provided with drainage at the bottom and with coarse soil as a bottom layer. On top of this layer was put fine, rich, well prepared soil, nearly filling the box. The soil was made level throughout. The seeds were then evenly scattered over the surface and were lightly covered with very fine soil. after which a small flat piece of board was used to gently press the soil cover. The box was then watered with fine spray from the sprinkler and kept in a germinating house in the college nursery, afterwards being watered once daily. Three days after planting, many slender seedlings appeared. It took 4 days for all the seeds to germinate. At this time, watering was done more carefully than before. The seedlings were pricked off into well prepared boxes as soon as they were ready, thus giving them more room and consequent freedom from "damping-off". Eventually, a heavy rainfall came and four boxes of seedlings which were left in the open were destroyed. Several hundred seedlings that were in the seed house were uninjured. These were transplanted to trial plots. Very close attention was given them after transplanting, but in spite of such care, each day some died off. One week in the plots finished the culture.

Some of the seeds that came from California were planted November 20, directly in well prepared plots. As these plots were in the direct sunlight, banana and abaca leaves were used as a cover. These plots were watered once daily for 15 days; but none of the seeds germinated. Some of the seeds were planted directly into the trial plots with careful attention, but none germinated. Some of these lots were also planted in boxes, with careful treatment, as described above, and even then, the results were not very satisfactory. Then the rest of the seeds were planted November 22, directly in the mountain plots, with the same cultural treatment but none germinated. These seeds included 18 varieties, each of which came in the usual small seed envelope. The average weight of the samples was almost 10 grams.

Cultivation was begun as soon as the leaves showed distinctly in the rows, using the hand cultivator. When the leaves of the onions became long and spreading, hoes were employed so that the cultivation was very shallow.

Watering was done during the dry season, as soon as the seed sets were planted, and also while the plants were beginning to send up leaves. In the early stages, there was a very rapid growth of the leaves each day. It took about 1½ weeks for this first stage of growth, after which but little watering was done. During the unbroken progress of the dry season (in the case of the third planting) the young onions were regularly supplied with water twice a week for one month. Watering was done systematically. The soil was deeply furrowed, the furrows being made parallel to the rows. Then the water was run through the furrows, just as a field would be irrigated. The furrows were then covered with soil which was formerly thrown out along the sides of the furrows. In this way the soil about the plants was always kept moist. In spite of this method of watering, these onions did not do as well as those in the two previous plantings. In the hottest part of the dry season, onions could be grown at all only by employing irrigation, except in places where the water table was very near the surface. In rainy weather, no water was given. No watering was done near

the time of harvesting of the hard, mature market bulb, while water was given to the green market onions up to the time of pulling. An instance of the injurious effect of watering near the harvesting time occured in the case of the native onions. One row of the onions was allowed to mature for seed bulbs, when a heavy rain came. One week after, many new green leaves replaced the yellow leaves and it was later noticed that the already formed bulbs were divided into numerous small slender bulbs. More serious results were noticed in the onion plants of the mountain plantings. Most of these mountain plants were destroyed by an excess of water. The few left were of no value whatever, being all tops.

At the time of maturity of the hard, market onion bulbs, the leaves turned yellow and the bulbs became hard and full, the skin on the bulbs showing its full, developed color. For green onions the plants are pulled while in very green and fresh condition.

The results of the first two plantings may be found in the Summary Table III, IV, and V and of the third planting in Table VI.

The preceeding three tables are made up from average rows in the trial plots. The computed yields per hectare are purely hypothetical. The trial plots are made in an old, long-cultivated field. In the cultural methods employed, these experiments were no better than ordinary field methods, in fact, perhaps not quite as good. They represent methods possible to the farmer with limited capital and were so planned. The hectare figures should be taken simply for what they are intended—simple estimates based upon average results in the trial plots.

The distance between rows in the trial plots (24 inches) was less than that recommended for field cultures, but sufficient to preclude root interference and provide the plants enough space for normal development. The recommended distance for field culture is a little greater, simply to admit the use of the cultivator. If hoed only, the same distance might be used.

SUMMARY OF FINDINGS AS TO MARKETING

According to the writer's experience the total cost of growing a hectare of onions in this locality by the extensive method varies from about ₱95 as a minimum up to about ₱270 as a maximum, depending on the kind of the seed stock employed.

In every case the cost of preparation, cultivation, harvesting and other expenses will amount to at least ₱80. On the average the cost of growing green onions, ranges from about ₱95 upward. A hectare planted to onion sets grown for green onions yields about 57,499 plants in the case of Variety No. 3339, and about 59,295 in No. 3338. The profit made by each of these two varieties is small, amounting to about ₱19.47 and ₱62.48, respectively.

Variety No. 3340, known as White Bermuda, is quite adapted to the local conditions. Big hard market bulbs were formed, the maximum diameter attained during three months' culture was 6 centimeters and its average was almost 4 centimeters. The cost of growing including the cost of the stocks amounted to about ₱171.07. The sale of the bulb that may be obtained from a hectare of land amounts to about ₱479.15. Deducting the expenses, a profit of about ₱308.08 per hectare may be made.

The cost of growing a hectare of green onions from large market onions is very high, running to about ₱2,581.00. The price obtained in selling the produce is is about ₱718.00. The loss in this case is very heavy, amounting to about ₱1,862. On the other hand, in the case of growing the ordinary small,

white market bulbs for the same purpose, the profit made is about ₱89, about ₱132 from the purplish inferior market bulbs and about ₱209 from the partially decayed market onions.

Nineteen varieties of seeds were planted directly in the field and in the germinating beds and in boxes in the college nursery. Eighteen varieties came from Germain Seed Co., California. Only the Silverskin variety, obtained through Luzon Floral Co., germinated. The seedlings however were not resistant to the local climatic conditions.

TABLE IV FOR THE THIRD PLANTING

Variety names	*No. of plants planted.*	*No. of plants produced.*	*Total weight of green onions or bulbs in grams.*	*Maximum weight of green onions or bulbs in grams.*	*Minimum weight of green onions or bulbs in grams.*	*Average weight in grams.*	*Total diameter in centimeters.*	*Maximum diameter in centimeters.*	*Minimum diameter in centimeters.*	*Average diameter in centimeters.*	*Maximum height at harvest in centimeters.*	*Minimum height at harvest in centimeters.*	*Average height at harvest in centimeters.*
Sets planted for green native 3120	178	712	487	1.3	0.6	0.68	462.8	1.4	0.2	0.96	27.5	10	17
Green 3338	42	42	472	22.5	1.5	11.2	36.54	2.1	0.6	0.88	47	16.1	30
Green 3339	41	41	259	18.6	1.0	6.3	36.08	1.9	0.4	0.88	43	9	27
Bulbs 3340	40	40	110	9.2	2.0	2.7	72.2	2.7	1.1	1.80	28.2	15	20.5

From Table VI it will be seen that forty-two of the Silverskin seed sets, Variety No. 3338 yielded 42 plants, weighed 472 grams (green onions), the maximum diameter being 2.1 centimeters and the minimum 0.6 centimeters. The average diameter was 0.88 centimeters. The average height is 30 centimeters. Forty-one of Variety No. 3339 (Brown sets) produced 41 plants weighing 259 grams. The total diameter obtained was 36.08 centimeters, maximum diameter, 1.9 centimeters; minimum, 0.4 and average, 0.88 centimeters. (The total weight is 259 grams, the maximum being 18.6 grams, and 1.0 gram for its minimum, the average being 6.3 grams). The maximum height is 43 centimeters, 9 centimeters for its minimum, and 27 centimeters for its average.

Forty seed-sets of Variety No. 3340 yielded 40 plants weighing 110 grams, the maximum weight of a bulb being 9.2 grams, 2.0 grams for its minimum and 2.7 grams for its average. The total diameter of bulbs is 72.2 centimeters, the maximum diameter being 2.7 centimeters, 1.1 centimeters for its minimum and 1.8 centimeters for its average. The maximum height at harvest was 28.2 centimeters, 15 centimeters for its minimum and 20.5 centimeters for its average.

One hundred and seventy eight seed bulbs of the native onions No. 3120 yielded 712 small bulbs, weighing 48 grams, the maximum weight being 1.3 grams, 0.6 gram for its minimum and 0.68 gram for its average. The total diameter of all the bulbs is 462.80 centimeters 1.4 centimeters for its maximum, 0.2 centimeters for its minimum and 0.68 centimeters for its average. The maximum height obtained was 27.5 centimeters, the minimum 10 centimeters and the average 17 centimeters.

The soil in which the college onion cultures were carried out is physically uniform in character. Both plots in the second and third plantings were richly and uniformly manured with equal amounts of carabao and cow dungs.

Comparing the results obtained in the second and in the third plantings, it is readily seen that the difference between them is due to the differences in seasonal conditions.

In all cases, the maximum, the minimum, and the average weight, diameter, and height of the onions produced in the second planting are two, three or four times as great as those obtained in the third planting.

OBSERVATIONS ON ONIONS GROWN IN FOREST DISTRICT AND HIGH ALTITUDES

The places selected for the observations were the summit of Mount Maquiling and coffee plantation located in the newly opened virgin forest which is about midway between the foot and summit of Mount Maquiling. Equal amounts of the same varieties of onion seeds, sets and bulbs used in each of the first and second plantings carried out in the college garden plots were planted in each of these two places. The two plantings were made in each of these two localities, one being on August 8th and the other on November 22nd. The plants were given uniform spaces of 10 by 24 inches in plots. They were given thorough cultivation once or twice a week. No water was given, however, as the plants were attended by frequent rainfall and dews.

The soil on the summit of Mount Maquiling is of varied character. The reddish yellow sub-soil has a depth of several feet. The brown top soil contains many rotting roots of plants. This soil is like a sponge which collects and retains the water. It yields free water on being squeezed by the hand.

In Mount Maquiling there is not such a definite season of hot and cold and of wet and dry as that of the college. This summit has a height of about 3460 feet above the sea level. The nights are quite cold. There is a heavy precipitation and filtration of moisture. This summit is frequently covered with fogs even in the dry season.

The vegetation consists of ferns, grasses, shrubs, herbs and trees, the branches of which are covered with sponge-like mosses usually saturated with moisture.

The coffee plantation is in the form of caiñgin, occupying an area of about one hectare. The high branching trees were left so that the soil is partially shaded throughout the day. Here the season is not very well distinguished either, but in general the climate is warmer than that of the summit of Mt. Maquiling, although cooler than that below, on the college ground.

This place has an altitude of about 350 meters above sea level. Rainfall occurs frequently. Vegetation consisted of large high branching trees, and orchids growing on the branches of trees, and many smaller trees from 10 to 30 feet in height.

The soil is of loamy clay of an almost compact form.

RESULT OF THE WORK

In general, none of the varieties showed any indication of adapting themselves to the mountain conditions. No bulbs of value were formed, even when large bulbs were planted.

Within about three or four weeks in the ground in this high mountain planting, many large, healthy leaves are at their maximum growth, having a height of about 65 centimeters in the case of the big hard market onions; about 50 centimeters in the small, hard market onions; about 52 centimeters in purple, hard market onions; about 61 centimeters in partially decayed market onions; about 66 centimeters in variety No. 3338; about 67 centimeters in No. 3339; and about 46 centimeters in the

native onions. After that time, the deterioration and decay of leaves follows rapidly. None of these varieties will make large bulbs under our conditions.

SUMMARY OF EXPERIMENTAL WORK

On the college farm, cultures of onions from all obtainable stocks were kept under way from June, 1914, to March, 1915, in the college trial plots. Each of these plots is 1/200 hectare. Three seasonal plantings were made; one in July, one in November, and one in December, which gave opportunity to study the cultures from the height of the wet season to the driest part of the dry season. Some of the same planting stock, so far as it was available, was used in all of these plantings.

Seed stocks from various sources were given thorough trial. Portions of all products were taken to local markets to get actual market estimates of their value. Plantings were also made at a medium and a high altitude on Mount Maquiling, under widely different conditions to serve as a check for comparison with cultures of the farm.

CONCLUSIONS

1. The demand for onions in the Philippines is always greater than the supply so that the price commonly runs very high, importations being very large. There are thus sound economic reasons for the development of onion culture in the Islands.

2. Near large towns and cities the growing of green onions is very profitable and but small capital is needed to start with.

3. The growing of onions is one of the simplest and most desirable occupations for the common farmer.

4. In this immediate region it has not proved to be practical to grow onions from seeds.

5. It pays well to plant the sprouted and partially decayed market onions for the purpose of raising green onions.

6. It is profitable to plant the big, hard market onions for the purpose of raising green onions.

7. It is very profitable and advisable to market the native onions as soon as usable, or they may be left to mature, as there is also a good demand for them.

8. The proper season for planting onions in this locality, according to our results, is about October or November. This time is about the close of the rainy season.

9. Sets of onions, numbers 3338 and 3339, cannot here be made to produce large, hard market onions; but there is reasonably good profit when they are grown for green onions.

10. The Bermuda onion sets, number 3340, developed many large, hard market bulbs, the maximum size being 6 centimeters and average, 4 centimeters.

11. More profit can be obtained from hard onion bulbs than from green onions, when it is possible to produce these from sets.

12. The experiments on the summit of Mount Maquiling and in the coffee plantation indicate that onions cannot be grown at a profit at these places.

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Weather Observations, October, 1917

By V. Ravara

	Rainfall mm.		Temperature in °C.				Wind in Miles			Atmometer Reading in cc.			
	Daily 6 p.m.	Weekly total	Maximum	Minimum	Mean Daily	Mean Weekly	Daily	Weekly	Cloudiness	Evaporation Daily	Evaporation Weekly	Insolation Daily	Insolation Weekly
Sept.													
29	.4		27.2	23.6	25.4		26.0			8.7		8.0	
30	6.3		27.8	23.7	25.7		25.3			7.7		6.6	
Oct.													
1	.2		27.8	23.2	25.5		34.2		½ cloudy	11.84		11.9	
2	2.5		28.2	22.9	25.5		17.3		"	13.44		15.33	
3	9.3		28.6	23.2	25.9		22.0		"	12.12		12.84	
4	.4		28.0	23.6	25.8		50.0		"	14.85		12.39	
5	1.9	21.0	26.6	23.6	25.1	25.6	64.5	239.3	"	8.36	77.01	5.39	72.45
6	53.7		27.8	23.4	25.6		42.5		rain	6.95		8.33	
7	19.9		28.9	23.7	26.3		53.3		¾ cloudy	15.04		12.78	
8	4.1		27.8	24.2	26.0		54.2		"	11.93		6.94	
9	11.5		25.6	22.6	24.1		24.2		"	7.80		9.57	
10	2.2		28.0	22.8	25.4		31.7		¾ "	11.09		8.17	
11	1.4		27.8	22.5	25.1		21.3		"	10.43		11.65	
12	2.3	95.1	27.8	23.6	25.7	25.5	39.8	267.0	¾ "	11.75	74.99	11.50	68.94
13	20.2		28.8	23.6	26.2		17.6		"	10.34		11.45	
14	37.3		26.9	22.2	24.5		18.2		clear	5.73		10.31	
15	1.5		28.0	22.8	25.4		17.9		½ cloudy	14.10		12.58	
16	0.3		27.8	23.6	25.9		24.5		partly cloudy	13.72		11.15	
17	14.3		28.0	23.0	25.5		32.0		¾ cloudy	11.37		7.87	
18	13.0		28.0	22.2	25.1		33.4		"	12.31		10.05	
19	1.3	87.9	27.6	23.5	25.5	25.4	36.3	179.9	clear	14.38	81.95	13.71	76.12
20	T		28.8	23.2	26.0		35.6		¾ cloudy	20.49		12.05	
21	2.5		28.0	23.8	25.9		23.1		½ "	12.40		10.16	
22	3.3		27.0	23.8	25.4		19.9		½ "	8.17		8.90	
23	5.3		27.5	23.9	25.7		17.5		"	7.61		7.77	
24	3.6		28.0	23.5	25.7		17.9		¾ "	7.42		6.54	
25	7.5		28.8	23.6	26.2		24.4		¾ "	13.81		10.17	
26	T	21.2	27.9	23.8	26.3	25.9	18.3	156.7	fair	11.75	81.65	11.88	67.47
27	13.2		27.8	23.1	25.4		19.3		clear	9.11		7.76	
28	2.4		28.8	23.2	26.0		27.1		½ cloudy	11.84		12.66	
29	1.4		28.8	23.8	25.8		35.4		½ "	13.25		12.85	
30	9.0		27.6	24.2	25.9		28.4		"	10.05		8.25	
31	1.2		28.8	23.8	25.8		50.2		¾ "	12.70		12.70	
	24	.7			25.6		952.0				372.55		339.2

College Coffee Plantation.

Sept. 29-Oct. 6	23.8	29.0	19.98	24.4
Oct. 6-13	83.3	27.8	20.00	23.9
13-20	68.2	26.8	20.1	23.4
20-27	58.5	27.0	20.0	23.5

Summit of Mount Maquiling

Sept 29-Oct 6	74.4
Oct. 6-13	91.0
13-20	91.5
20-27	79.0

The weather conditions were typical for the rainy season. Continuous rain hindered plowing and tilling of the soil. There was, however, more wind and more sunshine than in September, so that growth of most rainy-season crops was satisfactory.

Weather Observations, October, 1917

By V. Ravara

	Rainfall mm.		Temperature in °C.				Wind in Miles		Cloudiness	Atmometer Reading in cc.			
										Evaporation		Insolation	
	Daily 6 p.m.	Weekly total	Maximum	Minimum	Mean Daily	Mean Weekly	Daily	Weekly		Daily	Weekly	Daily	Weekly
Oct.													
27	13.2		27.8	23.1	25.4		19.3		clear	9.10		7.94	
28	2.4		28.8	23.2	26.0		27.1		½ cloudy	11.80		12.56	
29	1.4		28.8	23.8	26.3		35.4		½ "	13.30		12.85	
30	9.0		27.6	24.2	25.9		28.4		cloudy	10.00		8.25	
31	1.2		28.8	23.8	26.3		50.2		¾ cloudy	17.50		12.70	
Nov.													
1	7.8		27.5	23.6	25.5		43.3		½ cloudy	11.40		10.13	
2	14.7	49.7	28.0	23.8	25.9	26.1	36.1	239.8	cloudy	10.50	83.6	9.03	73.46
3	3.1		28.1	23.8	25.9		58.7		¾ cloudy	12.40		10.46	
4	16.4		26.6	23.6	25.1		24.8		cloudy	5.92		5.09	
5	4.0		28.6	24.0	25.8		41.5		"	11.93		11.71	
6	14.1		25.5	23.2	24.3		40.7		"	7.89		4.41	
7	15.5		24.4	23.4	23.9		47.4		"	3.57		1.62	
8	8.5		24.5	23.6	24.0		20.7		"	3.47		0.59	
9	12.3	73.9	26.7	23.2	24.9	25.0	47.6	281.4	"	7.14	52.32	3.11	36.99
10	14.4		29.0	23.6	26.3		31.4		½ cloudy	2.53		3.07	
11	T		28.1	24.1	26.1		35.5		partly cloudy	16.16		7.65	
12	9.0		26.8	23.6	25.2		72.1		cloudy	17.86		22.41	
13	0		27.9	23.7	25.8		54.5		½ cloudy	9.87		4.70	
14	0		27.8	23.8	25.8		52.3		½ cloudy	21.70		11.09	
15	0		28.5	23.6	26.0		36.0		cloudy	17.01		14.20	
16	0.3	23.7	26.8	23.9	25.3	26.0	48.3	330.1	"	18.42	103.55	7.99	71.11
17	24.1		25.1	22.6	24.3		43.0		"	8.46		4.51	
18	11.3		26.6	22.8	24.7		38.9		"	7.52		5.73	
19	14.7		25.1	23.6	24.3		39.5		"	6.58		.65	
20	3.6		25.8	23.4	24.6		16.0		"	5.35		7.33	
21	6.0		26.8	23.7	25.2		40.0		"	9.40		5.17	
22	4.5		25.9	23.5	24.7		20.9		"	6.29		4.79	
23	34.7	98.9	25.0	23.8	23.9	24.7	17.4	215.7	"	2.25	45.85	1.32	29.50
24	7.9		26.9	22.9	24.9		30.4		"	6.29		7.71	
25	10.8		25.2	24.0	24.6		——			——		——	
26	38.2		27.1	22.8	24.9		44.8		cloudy	9.11		11.18	
27	4.7		26.8	22.7	24.7		16.2		¾ cloudy	6.66		7.52	
28	0.8		27.5	22.9	25.2		16.4		cloudy	9.58		10.90	
29	1.5		28.8	22.9	26.3		23.1		½ cloudy	16.22		14.93	
30	0.3	64.2	27.8	23.4	25.4	25.3	23.5	154.4	¾ cloudy	16.45	64.31	14.57	66.81
		283.2				25.3		1061.0			287.93		223.57

	College	Coffee	Plantation
Nov.			
3-10	52.5	28.2	20.2
10-17	84.4	25.9	19.5
17-24	34.1	26.9	20.6
24-1 Dec.	10.19	23.2	20.2

	Summit of Mount Maquiling.
Nov.	
3-10	60.0
10-17	55.2
17-24	4.8
24-1 Dec.	10.0

On November 25 no observations were taken in the p. m. Therefore the readings of wind, evaporation and insolation on the 26th include those of the 25th and 26th.

The dry week from November 11 to 16 rendered the soil tillable but did not seem to have growing crops at all. The month was in general windy and cloudy.

College Notes

The following promotions have recently been made in the teaching staff of this college: Harold Cuzner, from associate professor of agricultural engineering to professor of the same; Charles S. Banks from associate professor of entomology to professor; Otto A. Reinking, from assistant professor of plant pathology to associate professor; Forman T. McLean, from assistant professor of botany to associate professor; Fred W. Ashton from assistant professor of chemistry to associate professor; and Francisco O. Santos, from assistant in mathematics to instructor.

Assistant Professor Joseph A. Cocannouer, of the Department of Agronomy, has been granted an extended leave of absence. He expects to sail for the States on February 15.

A bill appropriating the sum of ₱200,000, to be used in starting the graduates of this college in private farming, was approved by the Senate. It may be remarked in passing that this bill was prepared without previous consultation with the college authorities.

A bill appropriating the sum of ₱125,000 for the creation of an agricultural experiment station has been passed by the Legislature and is only waiting for the signature of the Governor-General in order to become a law.

Mr. Mariano B. Raymundo, instructor in agricultural economics, is on leave on account of illness.

Mr. Valente E. Villegas, '13, formerly of the fiber division of the Bureau of Agriculture, has been appointed instructor in animal husbandry in this college.

Mr. J. H. Lingle, of the Presbyterian Mission in China, delivered a lecture to the students in the college-chapel in the evening of February 8. His topic was "China: Today and To-morrow."

As a measure against unnecessary absences from military instruction, Acting Dean Baker has recently issued a circular making it obligatory for each student to render two hours of guard duty on Saturday for every hour of unexcused absence from the drills, the guard duty to consist of labor on the college farm.

Messrs. Hilarion S. Silayan, Mariano E. Gutierrez, Santiago Festin, Felix B. Sarao and Francisco Abadilla, of the Class of 1917, who are at present holding important positions in the Department of Mindanao and Sulu, were visitors at this college during the carnival week. They reported favorably and enthusiastically of conditions in Moroland.

The Provincial Governors' Delegation, consisting of about fifty of the governing officials of Mindanao, Sulu, and the Mountain Province, accompanied by President Villamor and a number of governors of the Christian Provinces, visited the college during the carnival week.

The class in animal husbandry made a trip to Alabang and the more important cattle farms and dairy establishments in the suburbs of Manila.

The class in horticulture made a trip to the fields bordering the Mariquina valley, where vegetables of all kinds are grown on an intensive scale, and to the Chinese market gardens in and about the City of Manila.

The class in Agronomy II visited the coconut plantations in Lucban, Tayabas Province, and the neighboring places, and secured data of plantation methods and accounting practiced in that locality.

UNIVERSITY OF THE PHILIPPINES

COLLEGE OF AGRICULTURE

LOS BAÑOS

The College of Agriculture has finished its eighth year with a student body of nearly 550. It occupies a tract of about one hundred and twenty-seven hectares on which every important crop in the Philippines is under cultivation. It has a large series of varieties of leading crops and very numerous introduced plants under tests and observation. The number of distinct cultures, not including series of fertilizer experiments, is more than two thousand. The college has seven concrete buildings and one of mixed materials.

The courses are:

A six-year course based on the completion of two years of the public high school course, and leading to the degree of Bachelor of Agriculture.

A four-year course based on the completion of the public high school course, and leading to the degree of Bachelor of Science in Agriculture.

Graduate work leading to the degree of Master of Science is given to persons holding the degree of Bachelor of Science.

Tuition for non-residents of the Philippines is ₱150.00 a year.

The college year will begin June 10, 1918.

For further information address the dean of the college.